2022-2091, -2115

United States Court of Appeals for the Federal Circuit

KOSS CORPORATION,

Appellant,

– v. –

KATHERINE K. VIDAL, Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office,

Intervenor.

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2021-00305 and IPR2021-00381

BRIEF FOR APPELLANT KOSS CORPORATION

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U.S. Patent 10,506,325 – Claims 1–4, 9, 10, and 14–17

1. Headphones comprising:

a pair of first and second wireless earphones to be worn simultaneously by a user,

wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected, wherein each of the first and second earphones comprises:

a body portion;

an earbud extending from the body portion that is inserted into an ear of the user when worn by the user;

a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user;

a wireless communication circuit for receiving and transmitting wireless signals;

a processor circuit connected to the wireless communication circuit;

at least one acoustic transducer for producing audible sound from the earbud;

a microphone for picking up utterances of a user of the headphones;

an antenna connected to the wireless communication circuit; and

a rechargeable power source; and

a docking station for holding at least the first wireless earphone, wherein the docking station comprises a power cable for connecting to an external device to power the docking station, and wherein the docking station is for charging at least the first wireless earphone when the first wireless earphone is placed in the docking station.

2. The headphones of claim 1, wherein: the wireless communication circuits are for receiving, wirelessly, streaming audio content; the at least one acoustic transducers are for playing the streaming audio content; and each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

3. The headphones of claim 1, wherein the processor circuit for the first earphone is for, upon activation of a user control of the headphones, initiating transmission of a request to a remote network server that is remote from the headphones.

4. The headphones of claim 3, wherein the processor circuit of the first earphone is further for receiving a response to the request.

9. The headphones of claim 1, the processor circuits of the headphones are configured to receive firmware upgrades transmitted from a remote network server.

10. The headphones of claim 9, wherein the headphone are configured to receive the firmware upgrades wirelessly.

14. The headphones of claim 10, wherein: the wireless communication circuits are for receiving, wirelessly, streaming audio content; the at least one acoustic transducers are for playing the streaming audio content; and each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

15. The headphones of claim 1, wherein the processor circuit of the first earphone is configured to: process audible utterances by the user picked by the microphone in response to activation of the microphone by the user; and transmit a communication based on the audible utterances via the Bluetooth wireless communication links.

16. The headphones of claim 1, wherein the rechargeable power source comprises

wirelessly chargeable circuit components.

17. The headphones of claim 1, wherein the rechargeable power source comprises a passive, wireless rechargeable power source.

U.S. Patent 10,491,982 – Claims 1–5 and 14–18

1. A system comprising:

headphones comprising a pair of first and second wireless earphones to be worn simultaneously by a user, wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected, wherein each of the first and second earphones comprises:

a body portion that comprises:

a wireless communication circuit for receiving and transmitting wireless signals;

a processor circuit in communication with the wireless communication circuit; and

an ear canal portion that is inserted into an ear of the user when worn by the user; and

at least one acoustic transducer connected to the processor circuit; and

an elongated portion that extends away from the body portion such that the elongated portion extends downwardly when the ear canal portion is inserted in the ear of the user;

a microphone connected to the processor circuit and for picking up utterances of a user of the headphones; an

antenna connected to the wireless communication circuit; and

a rechargeable power source; and

a mobile, digital audio player that stores digital audio content and that comprises a wireless transceiver for transmitting digital audio content to the headphones via Bluetooth wireless communication links, such that each earphone receives and plays audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player.

2. The system of claim 1, further comprising a docking station for holding at least the first wireless earphone, wherein the docking station comprises a power cable for connecting to an external device for charging the at least the first wireless earphone when the docking station is connected to the external device via the power cable.

3. The system of claim 1, wherein: in a first operational mode, the pair of first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the first and second earphones from the mobile, digital audio player via the Bluetooth wireless communication links; and in a second operational mode, the pair of first and second earphones play audio content streamed from a remote network server.

4. The system of claim 1, wherein the processor circuit of the first earphone is for, upon activation of a user control of the headphones, initiating transmission of a request to a remote network server that is remote from the mobile, digital audio player and in communication with the mobile, digital audio player via a data communication network.

5. The system of claim 4, wherein the processor circuit of the first earphone is further for receiving a response to the request.

14. The system of claim 1, wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server.

15. The system of claim 1, wherein the processor circuit of the first earphone is configured to: process audible utterances by the user picked by the microphone in response to activation of the microphone by the user; and transmit a communication based on the audible utterances via the Bluetooth wireless communication links.

16. The system of claim 1, wherein the rechargeable power source comprises a

wirelessly chargeable circuit component.

17. The system of claim 1, wherein the rechargeable power source comprises a passive, wireless rechargeable power source.

18. The system of claim 1, wherein each of the first and second earphones comprises a buffer for caching the audio content received by the earphone prior to being played by the at least one acoustic transducer of the earphone.

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

CERTIFICATE OF INTEREST

Case Number 2022–2091, 2022–2115

Short Case Caption Koss Corp. v. Vidal

Filing Party/Entity Koss Corp.

Instructions: Complete each section of the form. In answering items 2 and 3, be specific as to which represented entities the answers apply; lack of specificity may result in non-compliance. **Please enter only one item per box; attach additional pages as needed and check the relevant box**. Counsel must immediately file an amended Certificate of Interest if information changes. Fed. Cir. R. 47.4(b).

I certify the following information and any attached sheets are accurate and complete to the best of my knowledge.

Date: Nov. 28, 2022

Signature: /s/ *Mark G. Knedeisen*

Name: Mark G. Knedeisen

1. Represented Entities. Fed. Cir. R. 47.4(a)(1).	**2. Real Party in Interest.** Fed. Cir. R. 47.4(a)(2).	**3. Parent Corporations and Stockholders.** Fed. Cir. R. 47.4(a)(3).
Provide the full names of all entities represented by undersigned counsel in this case.	Provide the full names of all real parties in interest for the entities. Do not list the real parties if they are the same as the entities. ☒ None/Not Applicable	Provide the full names of all parent corporations for the entities and all publicly held companies that own 10% or more stock in the entities. ☒ None/Not Applicable
Koss Corp.		

☐ Additional pages attached

4. Legal Representatives. List all law firms, partners, and associates that (a) appeared for the entities in the originating court or agency or (b) are expected to appear in this court for the entities. Do not include those who have already entered an appearance in this court. Fed. Cir. R. 47.4(a)(4).

☐ None/Not Applicable ☐ Additional pages attached

K&L Gates LLP	Mark G. Knedeisen	Christopher M. Verdini
Laurén Murray	Brian P. Bozzo	Michelle Weaver
Ragae M. Ghabrial		

5. Related Cases. Provide the case titles and numbers of any case known to be pending in this court or any other court or agency that will directly affect or be directly affected by this court's decision in the pending appeal. Do not include the originating case number(s) for this case. Fed. Cir. R. 47.4(a)(5). See also Fed. Cir. R. 47.5(b).

☐ None/Not Applicable ☐ Additional pages attached

Koss Corp. v. Skullcandy, Inc., Nos. 2:21–cv–00203–DBB (D. Utah)
Koss Corp. v. PEAG LLC, No. 3:21–cv–01177–CAB–JLB (S.D. Cal.)
Koss Corp. v. Plantronics, Inc., No. 4:21–cv–03854–JST (N.D. Cal)

6. Organizational Victims and Bankruptcy Cases. Provide any information required under Fed. R. App. P. 26.1(b) (organizational victims in criminal cases) and 26.1(c) (bankruptcy case debtors and trustees). Fed. Cir. R. 47.4(a)(6).

☒ None/Not Applicable ☐ Additional pages attached

TABLE OF CONTENTS

Page

TABLE OF AUTHORITIES

Page(s)

Cases:

Statutes & Other Authorities:

STATEMENT OF RELATED CASES

This consolidated appeal arises from final written decisions in both IPR2021–00305 concerning U.S. Patent No. 10,506,325 B1 ("the '325 Patent") and IPR2021–00381 concerning U.S. Patent No. 10,491,982 B1 ("the '982 Patent"), both assigned to Koss Corporation, which is the appellant in this consolidated appeal. The petitioner for both *inter partes* review (IPR) proceedings was Apple Inc. ("Petitioner"), which is not a party to this appeal. *See* Case No. 2022–2091, Dkt. No. 11 (Fed. Cir. Sept. 2, 2022).

This appeal may affect the following pending litigations involving the '325 and/or '982 Patents: *Koss Corp. v. PEAG LLC*, No. 3:21–cv–01177–CAB–JLB (S.D. Cal.) ('325 and '982 Patents); *Koss Corp. v. Plantronics, Inc.*, No. 4:21–cv–03854–JST (N.D. Cal) ('325 Patent); and *Koss Corp. v. Skullcandy, Inc.*, No. 2:21–cv–00203–DBB (consolidated with Case No. 2:21–cv–00557–DBB) (D. Utah) ('325 and '982 Patents).

The following pending Federal Circuit appeals involve patents in the same family as the '325 and '982 Patents: *Koss Corp. v. Bose Corp.*, Case No. 2022–2090 (Fed. Cir.) (U.S. Patent No. 10,368,155); *Koss Corp. v. Bose Corp.*, Case No. 2023-1179 (Fed. Cir.) (U.S. Patent No. 10,206,025); and *Koss Corp. v. Bose Corp.*, Case No. 2023-1173 (Fed. Cir.) (U.S. Patent No. 10,469,934).

JURISDICTIONAL STATEMENT

The Board had jurisdiction under 35 U.S.C. §§ 311–315, and issued its Final Written Decisions on May 31, 2022, for the '325 Patent in IPR2021–00305 (Appx1–60), and on June 27, 2022, for the '982 Patent in IPR2021–00381 (Appx61-137). Koss Corporation filed timely Notices of Appeal on, respectively, August 1, 2022, for IPR2021–00305 and August 9, 2022, for IPR2021–00381. Appx735–737; Appx5023–5025. This Court has jurisdiction under 35 U.S.C. §§ 141–144, 319 and 28 U.S.C. § 1295(a)(4)(A).

STATEMENT OF THE ISSUES

1. Whether there is substantial evidence supporting the Board's determination that independent claim 1, as well as claims 2–4, 9, 10, and 14–17 depending therefrom, of the '325 Patent are unpatentable under 35 U.S.C. § 103.

2. Whether the Board erred, both in its legal conclusions and factual findings, by applying inapposite caselaw, namely *In re Keller*, 642 F.2d 413 (C.C.P.A. 1981) and *In re Epstein*, 32 F.3d 1559 (Fed. Cir. 1994), resulting in the Board improperly, and non-harmlessly, ignoring Koss's evidence that independent claim 1, as well as claims 2–5 and 14–18 depending therefrom, would not have been obvious.

STATEMENT OF THE CASE

I. THE ’325 AND ’982 PATENTS

The ’325 and ’982 Patents are assigned to Koss Corporation (“Koss”). Each patent claims priority via several continuation applications to a PCT application, PCT/US2009/039754, filed April 7, 2009, and to a provisional application, Serial No. 61/123,265, filed April 7, 2008. Appx138–139, field codes (60), (63); Appx167–168, field codes (60), (63). The two patents, which disclose various types of wireless earphones, have identical written descriptions and figures. The patents describe various functional features for the wireless earphones, such as transitioning automatically between wireless networks (*see* Appx161–162, 10:10–11:67), signal processing in the wireless earphones (Appx160, 7:30–37), and firmware upgrades pushed to the wireless earphones (Appx161, 9:47–10:9).[1] The patents also describe various earphone form factors, including independently wireless earphones, i.e., discrete earphones that are not physically connected when worn by a user, that are each wireless, and that are worn in separate ears of the user. Appx141; Appx143; Appx158, 3:16–55.

[1] Citations to disclosures in the ’325 and ’982 Patents herein are to the ’325 Patent unless otherwise noted for sake of simplicity as the specifications of the two patents are identical.

The patents describe two general types of wireless networks via which the wireless earphones can stream content: "ad hoc" and "infrastructure" wireless networks. According to the patents, an ad hoc wireless network is "a network where two (or more) wireless-capable devices … communicate directly and wirelessly, without using an access point." Appx158, 3:7–10. Bluetooth is an example of an ad hoc wireless link. *Id*., 4:59–64. An infrastructure wireless network, on the other hand, "is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet)." *Id*., 3:10–15. The wireless earphones may stream, via a wireless network, digital audio content from various sources, such as a mobile, digital audio player ("DAP"), a laptop, or a server connected to the Internet. Appx158, 4:31–39; Appx159, 5:58–64. To receive and play the streamed content, each wireless earphone comprises a "transceiver circuit," which may be implemented as a single integrated circuit, such as a system-on-chip ("SOC"). Appx158, 3:50–52 (each earphone may comprise a transceiver circuit); Appx159–160, 6:30–8:9 (components of transceiver circuit); Appx148 (Fig. 3 is a block diagram of a transceiver circuit). Using an SOC in the earphones "is conducive to miniaturizing the components of the earphone, which is advantageous if the earphone is to be relatively small in size, such as an in-ear earphone (see FIGS. 1A–1B for example)." Appx159, 6:47–

50 (reference numbers omitted).

With reference to Figure 3 of the patents, reproduced below, the transceiver circuit 100 includes a processor 114, which can include a digital signal processor ("DSP") 118. Appx160, 7:30–32. The DSP may "perform various sound quality enhancements" for the earphone, such as "noise cancellation and sound equalization." *Id.*, 7:34–37. The processor can execute firmware, which is stored in a memory 120, 122 of the transceiver circuit, to implement the various functionalities described in the patents for the wireless earphones, such as transitioning between wireless networks. Appx160, 7:45–49. The patents describe various ways in which the earphones could receive firmware upgrades, including a host server pushing firmware upgrades to the wireless earphones. Appx161, 9:47–10:9; Appx150 (Fig. 5).

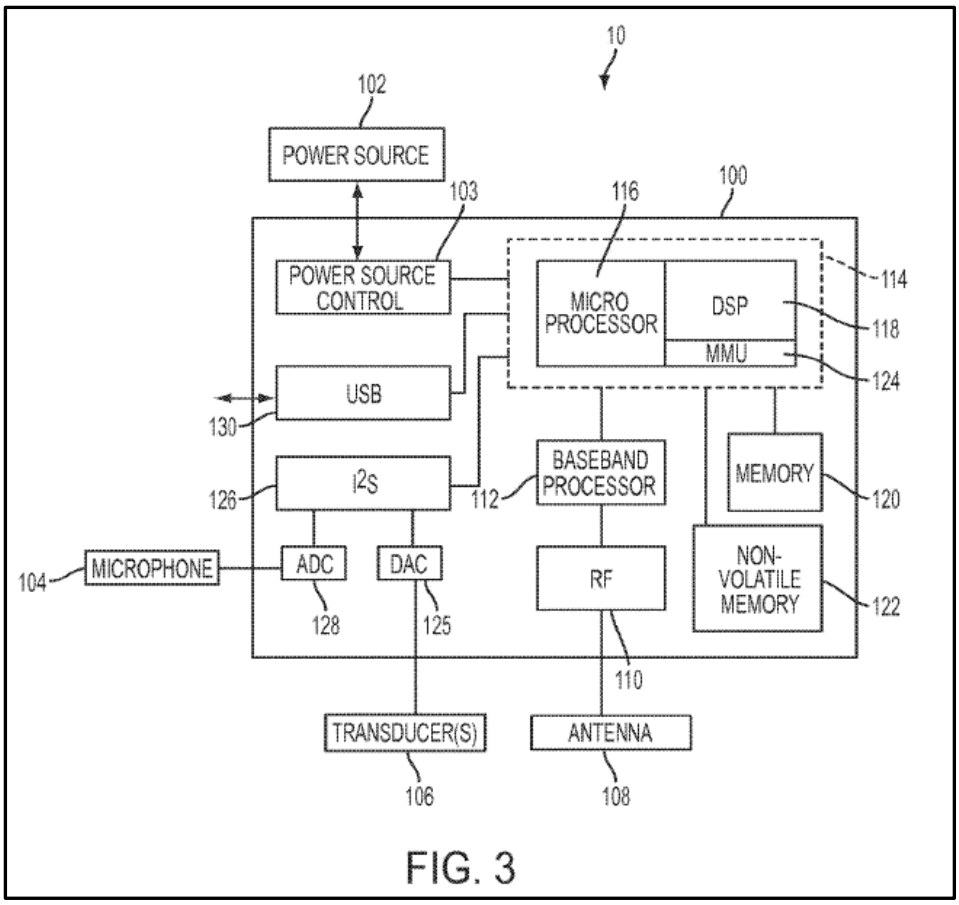


FIG. 3

Relevant to this consolidated appeal, two independently wireless earphone form factors described in the patents are: (1) an earphone with a "hanger bar" that extends over the top of the user's ear (Appx143, Figs. 1D–1E; Appx158, 4:4–25); and (2) an earphone with both an earbud that extends into the ear of the user and a downwardly extending elongated portion (Appx141, Fig. 1B; Appx158, 3:16–25). The claims of the '325 Patent are limited to the first form factor type, i.e., earphones with a hanger bar (Appx165, 18:16–20), whereas the claims of the '982 Patent are limited to the second form factor type, i.e., earphones with an earbud and an elongated, downwardly extending portion (Appx194, 18:25–28).

Figures 1D–1E of the patents (reproduced below) show the first form factor type. In this type of wireless earphone, the hanger bar 17 allows the earphone 10 "to clip to, or hang on, the user's ear …." Appx158, 4:4–6. The hanger bar "rests upon the upper external curvature of the listener's ear behind the upper portion of the auricula (or pinna)." *Id.*, 3:15–18. The wireless earphone also includes a speaker 106–A, which is inserted into the user's ear. *Id.*, 4:10–12. In various embodiments, such as shown in Figures 1D–1E, the wireless earphone could include a second speaker 106–B, which is next to, but not inserted into, the user's ear. *Id.*, 4:12–13.

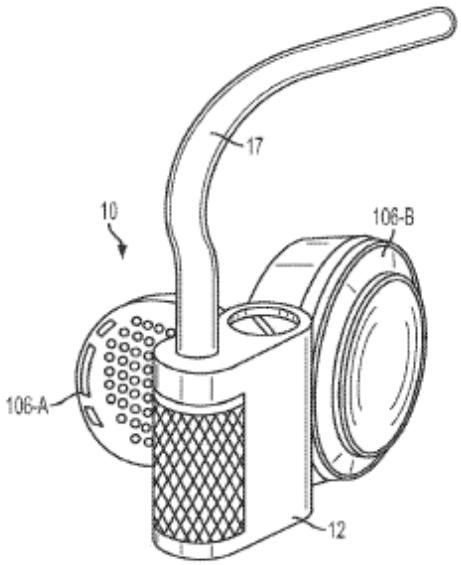


FIG. 1D

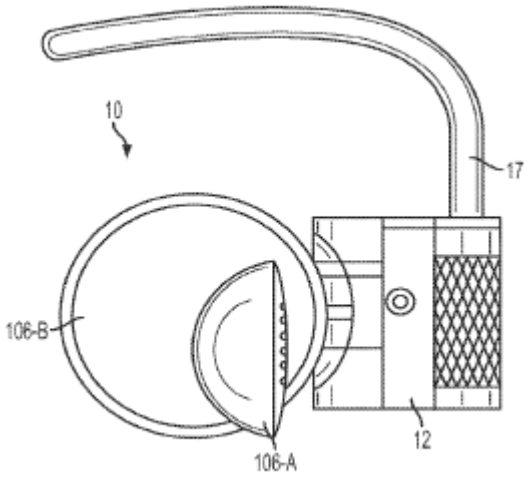


FIG. 1E

Figure 1B (reproduced below) shows the second form factor type. This earphone includes a body portion 12, which comprises an ear canal portion 14 that

is inserted into the user's ear. Appx158, 3:21–23. The body portion 12 also includes an exterior portion 15, which is not inserted into the user's ear. *Id.*, 3:24–25. The exterior portion also includes the elongated portion that extends downwardly.

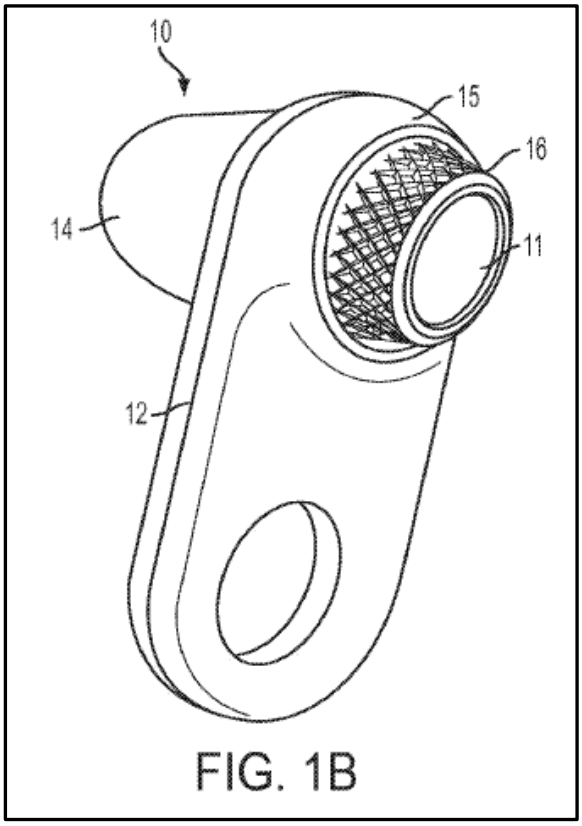


FIG. 1B

The transceiver circuit may be housed in the body portion of the earphone for each form factor type. Appx158, 3:36–37. The earphones' circuitry can also include a rechargeable battery, which can be charged via a docking station for the earphones. Appx159, 6:60–67; Appx160, 8:5–8; Appx148 (Fig. 3 shows power source 102); Appx149 (Fig. 4A shows docking station 200).

The '325 Patent includes eighteen claims, with claim 1 being the sole

independent claim. Claim 1 is directed to headphones that comprise "a pair of first and second wireless earphones to be worn simultaneously by a user," where the two earphones "are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected …." Appx165, 18:5–11. Each of the earphones also comprises "a curved hanger bar" with a "portion that rests on an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user …." *Id.*, 18:16–20. Claim 1 also recites the docking station "for charging at least the first wireless earphone when the first wireless earphone is placed in the docking station." *Id.*, 18:32–38.

The '982 Patent includes twenty claims, with claim 1 being the sole independent claim. Claim 1 is directed to a system that comprises headphones and a "mobile, digital audio player." Appx194, 18:8–40. Like the '325 Patent, the claimed headphones in the '325 Patent comprise "a pair of first and second wireless earphones to be worn simultaneously by a user," where the two earphones "are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected …." *Id.*, 18:9–14. Unlike the '325 Patent, the claimed earphones of the '982 Patent comprise a body portion with an "ear canal portion" and "an elongated portion that extends downwardly from the body portion such that the elongated portion extends downwardly when the ear canal portion is inserted in the ear of the user …." *Id.*, 18:16–28. The claimed

"mobile, digital audio player … stores digital audio content and … comprises a wireless transceiver for transmitting digital audio content to the headphones via Bluetooth wireless communication links, such that each earphone receives and plays audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player." *Id.*, 18:34–40.

The claims of the '982 Patent do not recite "a curved hanger bar," as claimed in the '325 Patent, and the claims of the '325 Patent do not recite "an elongated portion that extends downwardly from the body portion," as claimed in the '982 Patent.

II. DISTRICT COURT PROCEEDINGS

Koss sued Petitioner for patent infringement on July 22, 2020, in the United States District Court for the Western District of Texas, asserting several patents, including the '325 and '982 Patents. *Koss Corp. v. Apple Inc.*, Case No. 6:20–cv–00665 (W.D. Tex.); Appx43; Appx63; Appx3340; Appx1580–1582. The district court construed some terms in the '325 and '982 Patents, Appx3953–3954, although those constructions were not germane to the IPRs and are not germane to this consolidated appeal. Prior to any adjudication of the validity of any claims of the '325 and '982 Patents, Koss and Petitioner "resolved all matters in controversy between them," such that the district court dismissed the case. *Koss Corp. v. Apple Inc.*, Case No. 6:20–cv–00665, Dkt. Nos. 303 and 304 (W.D. Tex. Jul. 23, 2022).

On the same day that Koss sued Petitioner, Koss also sued, also in the Western District of Texas, other parties for infringing, among other Koss patents, the ’325 and ’982 Patents. Koss sued both PEAG d/b/a JLab Audio and Skullcandy, Inc., for infringing both the ’325 and ’982 Patents. *Koss Corp. v. PEAG LLC*, Case No. 6:20–cv–00662 (W.D. Tex.); *Koss Corp. v. Skullcandy, Inc.*, Case No. 6:20–cv–00664 (W.D. Tex.); Appx364. Koss asserted the ’325 Patent, but not the ’982 Patent, against Plantronics, Inc. *Koss Corp. v. Plantronics, Inc.*, Case No. 6:20–cv–00663 (W.D. Tex.); Appx4548. These three cases are presently pending after being refiled in or transferred to, as the case may be, other venues. *Koss Corp. v. PEAG LLC*, Case No. 3:21–cv–01177, Dkt. No. 40 (S.D. Cal. Oct. 5, 2021); *Koss Corp. v. Skullcandy, Inc.*, Case No. 2:21–cv–00203, Dkt. No. 43 (D. Utah July 21, 2021); *Koss Corp. v. Plantronics, Inc.*, Case No. 4:21–cv–03854, Dkt. No. 79 (N.D. Cal. Oct. 18, 2021).

III. *INTER PARTES* REVIEW PROCEEDINGS

Petitioner filed two IPRs for each of the ’325 and ’982 Patents. The first IPR for each patent was instituted and the Board’s final written decisions (“FWDs”) for those two IPRs are the subject of this consolidated appeal. Appx1–60 (FWD for IPR2021–00305 for the ’325 Patent); Appx61–137 (FWD for IPR2021–00381 for the ’982 Patent). The Board did not institute Petitioner’s second IPR for either patent. *Apple Inc. v. Koss Corp.*, IPR2021–00679, Paper 14

(PTAB Oct. 12, 2021) ('325 Patent); *Apple Inc. v. Koss Corp.*, IPR2021–00686, Paper 12 (PTAB Oct. 12, 2021) ('982 Patent).

In the two instituted IPRs, Petitioner relied on expert testimony from Jeremy Cooperstock, Ph.D. ("Cooperstock"), who has a Ph.D. in electrical and computer engineering and is a professor at McGill University. Appx10; Appx70; Appx1247, ¶¶ 6–7; Appx5516, ¶¶ 6–7. In both IPRs, Koss relied on testimony from both Joseph C. McAlexander III ("McAlexander") and Nicholas S. Blair ("Blair"). Appx10; Appx70. McAlexander has a Bachelor of Science degree in electrical engineering and worked for many years at Texas Instruments. Appx4045–4048, ¶¶ 3–9; Appx8821–8823, ¶¶ 3–9. Blair is the Director of Product for Koss and has developed several earphone models over his career, such that "a significant focus of [his] work has been on the design of earphones." Appx4126, ¶¶ 1–4; Appx8910, ¶¶ 1–4.

A. IPR2021–00305 for the '325 Patent

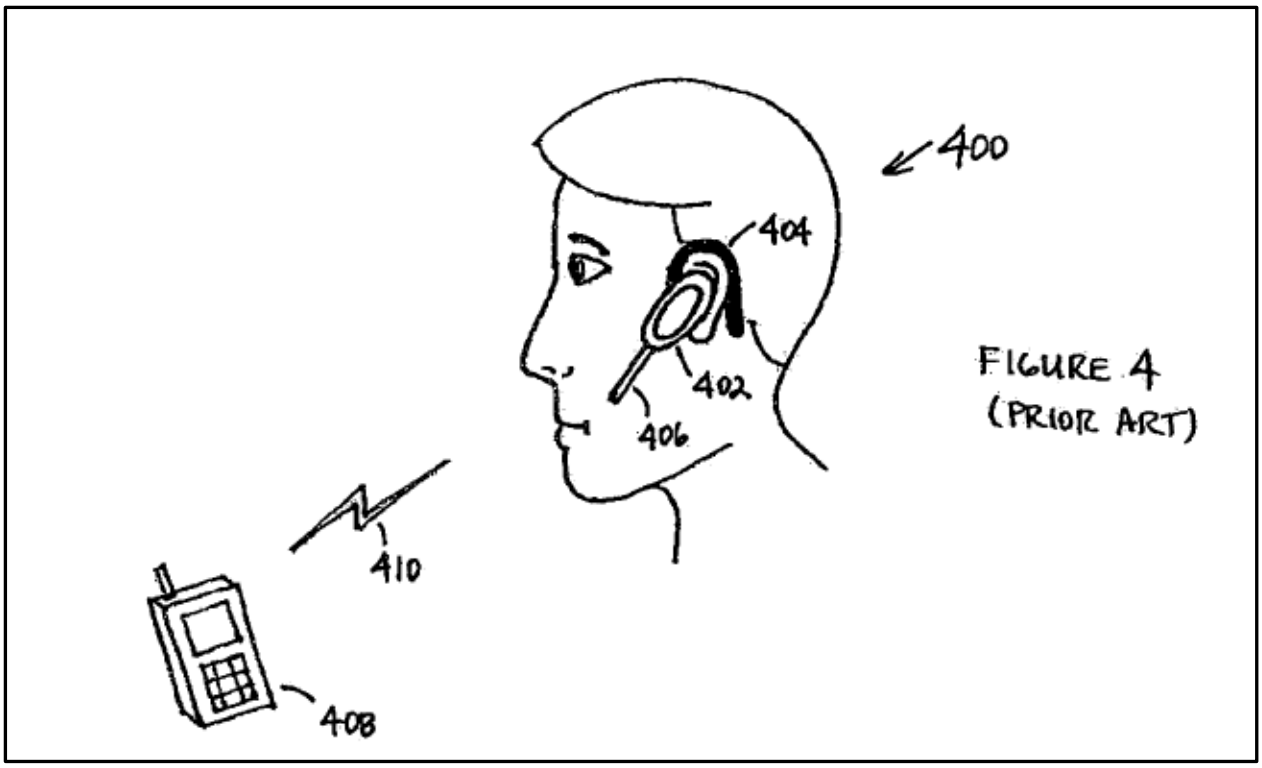
1. Asserted Grounds and Evidence

In IPR2021–00305, Petitioner petitioned that claims 1–4, 9, 10, and 14–18 of the '325 Patent are invalid under 35 U.S.C. § 103 on the following grounds, which the Board instituted:

Ground	Claims	References
1A	1, 2, 16–18	Rosener, Huddart
1B	3, 4	Rosener, Huddart, Haupt
1C	9, 10, 14	Rosener, Huddart, Price
1D	15	Rosener, Huddart, Paulson
1E	16, 17	Rosener, Huddart, Vanderelli

Appx208; Appx11; Appx386.

For Ground 1A, Petitioner relied on Rosener to show all of claim 1's limitations except the rechargeable power source and the docking station, for which Petitioner relied on Huddart. Appx233–234; Appx19. Rosener discloses, at Figure 4 thereof (shown below), "an illustration of a user wearing a prior art Bluetooth enabled over-the-ear monoaural wireless headset." Appx1419, ¶ [0017]; Fig. 4. The single earphone shown in Figure 4 includes "an earloop 404 that is configured to fit around the outer ear of the user 400." Appx1418, ¶ [0008]. Rosener's Figure 4 headset is "monoaural" because "it operates with only one of the user's two ears." *Id.* It also includes "a voice tube 406 for directing sound from the user's voice to a microphone within the headphone housing." *Id.*



Rosener shows another wireless earphone form factor in Figure 5 (shown below), which is "an illustration of a user wearing a wireless headset comprising first and second wireless earphone[s] …." Appx1419, ¶ [0018]. The earphones shown in Figure 5 include an earbud and a downwardly extending member. Important to this appeal, Rosener discloses that the earphones "may be in the form of an earbud designed to fit into the concha of the pinna of the user's ear," which is what appears to be shown in Figure 5, but Rosener also discloses that the earphones may be in the form of "a canalphone, which can be fitted within the ear canal of the user's ear; an over-the-ear circum-aural type headphone; or any other suitable configuration that may be attached to, worn on, or fitted within the user's ear." *Id.*, ¶ [0030]. Rosener further discloses that the earphones "may further

include a clip, earloop, or other suitable securing mechanism to help maintain the earphone 502 or 504 on the ear of the user." Appx1420, ¶ [0030].

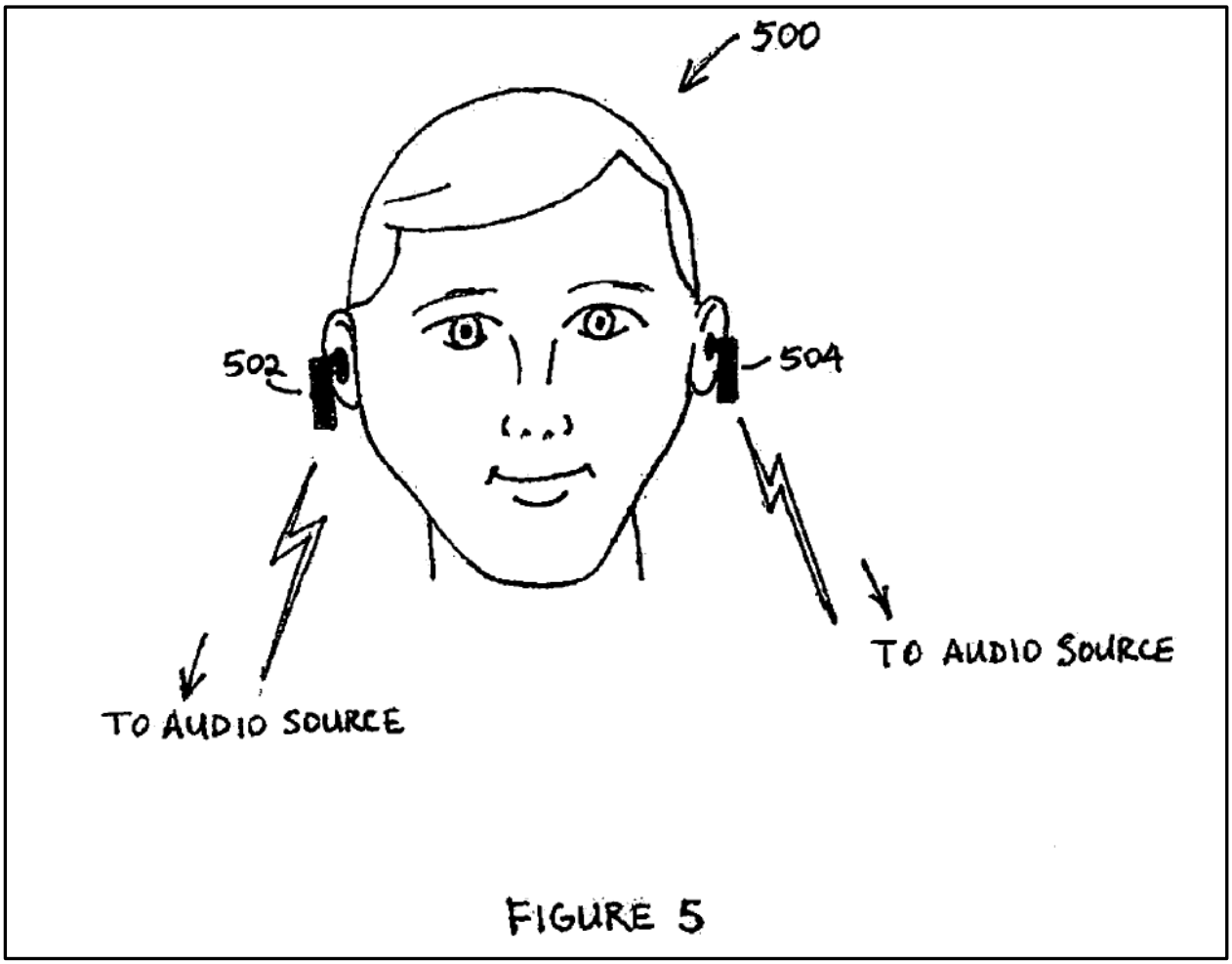
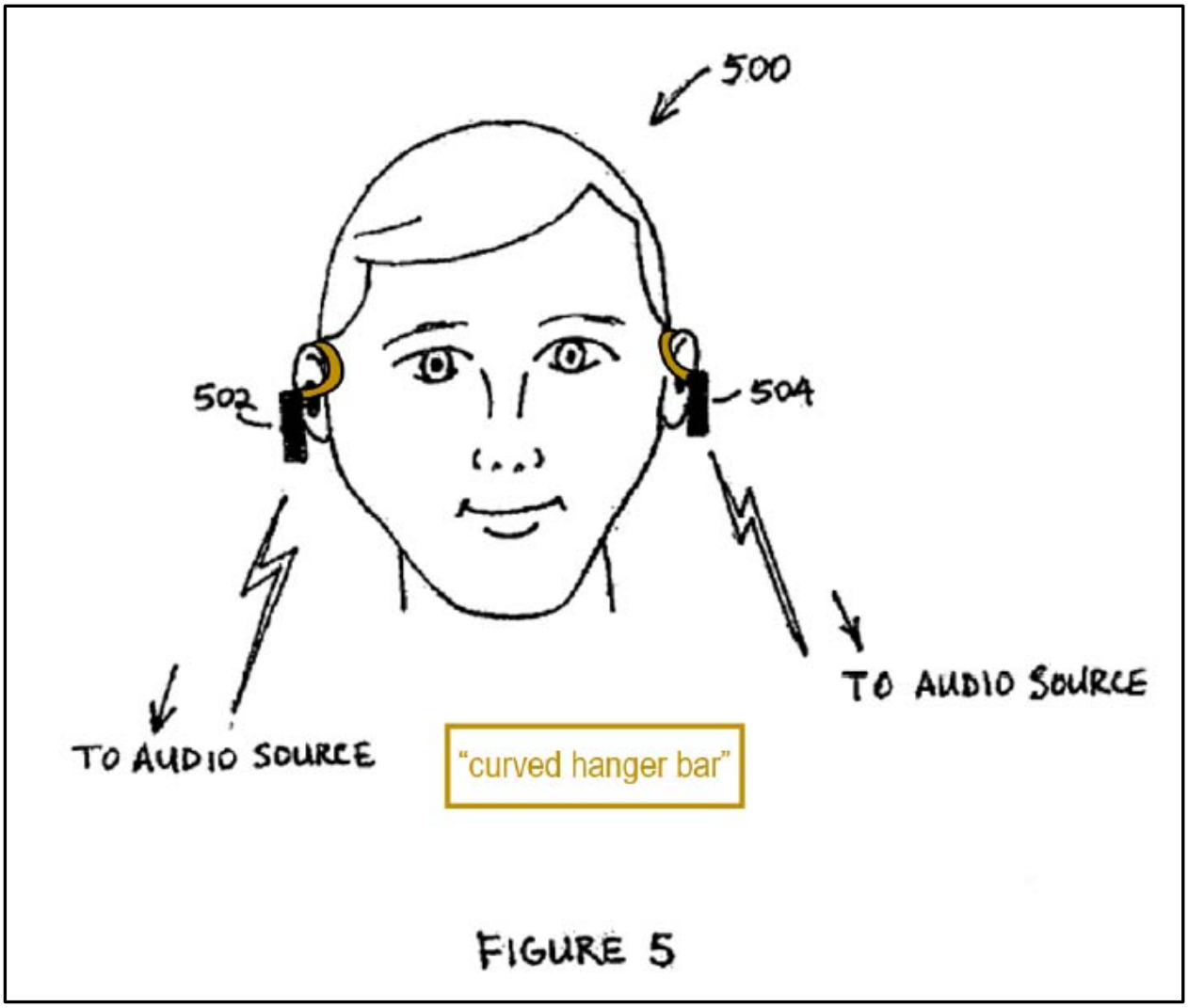


FIGURE 5

Petitioner and Cooperstock relied on a modified version (shown below) of Rosener's Figure 5 to assert that the earphone structure of claim 1 of the '325 Patent, with its body portion, earbud, and curved hanger bar, would have been obvious. Appx242–244; Appx1295–1296, ¶ 84. Petitioner's modified Figure 5 combines securing mechanisms from two different embodiments of Rosener: (1) the earbud and the downwardly extending member of Rosener's Figure 5; and

(2) the earloop of Rosener's Figure 4.



Blair, who has a background developing earphones (Appx4126–4127, ¶¶ 4–5), testified that adding an earloop to an earphone with an earbud and a downwardly extending member, as shown in Petitioner's modified Figure 5, would counteract the securing forces of the earbud-downwardly extending member earphone and actually work to pry the earbud out of the user's concha (i.e., the bowl-shaped cavity just outside the opening of the ear canal). Appx4135–4136,

¶ 16; Appx4128, ¶ 7.[2] Blair explained that, with respect to the earphones depicted in Rosener's Figure 5, "the downwardly-extending member for each earphone is intended to extend through the intratragal notch of the user's ear.… The weight of the downwardly-extending member serves to keep the earbud seated on the lower portion of the concha of the user's ear so that the earbud tends to stay on (or secured in) the user's ear." Appx4131–4132, ¶ 12. According to Blair, the earloop in Rosener's Figure 4 also exerts a force acting on the earphone to hold it in place. Appx4133–4134, ¶14. However, such a force is exerted toward the back of the ear (i.e., in the opposite direction of the boom mic that would be extending to the user's mouth). *Id.* If the two securing mechanisms were combined—that is, the earloop combined with the earbud-downwardly extending member of Rosener's Figure 5, which is the combination relied upon by the Petitioner and its expert—the result would be a force that "extends in a direction that would tend to displace the in-ear portion of the earbud out of the concha, displace the downwardly projecting member out of the intratragal notch, and/or displace the earloop from around the user's ear. In effect, the ***resultant force would essentially pry the earbud out of the concha***, which would lessen the sound quality characteristics of

[2] Blair's declaration describes the anatomy of the human ear. Appx4128-4129, ¶¶ 7-8.

the earbud and result in earphones that are uncomfortable for the user." Appx4135–4136, ¶ 16 (emphasis added).

Petitioner did not depose Blair. Instead, in response to Blair's testimony, Petitioner proffered more testimony from Cooperstock. Appx2771–2800. Cooperstock disagreed with Blair's testimony because it "assume[d] a specific configuration of the earphones that includes a downwardly-extending member," Appx2778, ¶ 13, although neither Petitioner nor Cooperstock proposed an alternative configuration than what is shown in Petitioner's modified Figure 5 of Rosener. Cooperstock also asserted that Blair's analysis of the applicable forces "miss[es] several forces that would be acting on the earphones when they are worn by the user," including that Blair's analysis failed to compute the center of mass for the modified Rosener earphones. Appx2781–2786, ¶¶ 19–28. Puzzlingly, however, Cooperstock testified that such an analysis would be impossible: "without having specification of the parameters, the weights of the different elements, the components, the attachment, the coefficient of friction, [Cooperstock] would not be able to perform such calculations." Appx4273. To that end, Cooperstock did not construct the modified Rosener earphones, did not create a computer model for them, did not compute the center of mass, and did not perform any mathematical calculations of the forces that would be acting on the earphones. Appx4272–4273. Further, in stark contrast to Blair's significant

earphone design experience, Cooperstock had only ever designed a single pair of earphones, which design took place in the "early 1970s." Appx4260–4261. The earphones designed by Cooperstock fifty years ago were "fairly simple, using existing components of speakers, wires, [and] power supply." Appx4261. They were not wireless and not commercially sold, and Cooperstock does not have any patents on headphones. *Id*.

2. Final Written Decision

In the FWD, the Board found that Petitioner proved by a preponderance of the evidence that claims 1–4, 9, 10, and 14–17 of the '325 Patent are unpatentable under § 103, but that Petitioner had not proved that dependent claim 18 is unpatentable. Appx2. The Board adopted Petitioner's proposed skill level for the relevant person having ordinary skill in the art ("POSITA"), which was "at least a Bachelor's Degree in an academic area emphasizing electrical engineering, computer science, or a similar discipline, and at least two years of experience in wireless communications across short distance or local area networks." Appx13 (citing Appx1262, ¶ 34). Koss proposed a slightly different POSITA standard, but acknowledged that the difference in skill level would not lead to a different result. Appx13.

Relevant to claim 1, the Board found that it "need not evaluate which of the experts' views on the various forces on a Figure 4/5 combination would have been

correct" because "Rosener expressly describes earbuds with curved hanger bars" based on Rosener's ¶ [0030]. Appx23–24. The Board read Petitioner's modified Figure 5 in the petition as merely "an illustration of how these expressly described features might look together, as Rosener does not have a figure depicting that embodiment" and did not read it "as a proposed physical combination of different embodiments within Rosener." Appx23.

The Board also found that dependent claims 2–4, 9, 10, and 14–17 would have been obvious under the asserted invalidity grounds. Appx28–30; Appx50–58. The Board, however, concluded that Petitioner failed to show that claim 18 was unpatentable. Appx30–40.

B. IPR2021–00381 for the '982 Patent

1. Asserted Grounds and Evidence

In IPR2021–00381, Petitioner petitioned that claims 1–5 and 14–20 of the '982 Patent are invalid under § 103 on the following grounds, which the Board instituted:

Ground	Claims	References
1(A)	1, 2, 18–20	Rosener, Hankey
1(A)(i)	1, 2, 18–20	Rosener, Hankey, Dyer
1(B)	3, 5	Rosener, Hankey, Haupt
1(B)(i)	3, 5	Rosener, Hankey, Haupt, Dyer
1(C)	14	Rosener, Hankey, Price

Ground	Claims	References
1(C)(i)	14	Rosener, Hankey, Price, Dyer
1(D)	15	Rosener, Hankey, Paulson
1(D)(i)	15	Rosener, Hankey, Paulson, Dyer
1(E)	16, 17	Rosener, Hankey, Huddart
1(E)(i)	16, 17	Rosener, Hankey, Huddart, Dyer
1(F)	17	Rosener, Hankey, Huddart, Vandarelli
1(F)(i)	17	Rosener, Hankey, Huddart, Vandarelli, Dyer

Appx4432; Appx71; Appx4638.

For Grounds 1(A) and 1(A)(i), Petitioner acknowledged that Rosener is "silent as to the implementation details of arranging Rosener's electrical components within the compact form factor of each of the earphones" shown in Rosener's Figure 5 and that Rosener "contains only a limited disclosure of the details of the earphones' form factor." Appx4456 (citing Appx5543, ¶ 45). To overcome (allegedly) these deficiencies of Rosener, Petitioner relied on Hankey, which Petitioner asserted provides "techniques to implement a headset within 'a small compact unit.'" Appx4452 (citing Appx5784, ¶ [0093]; Appx5785–5786, ¶ [0103]). Hankey discloses a single-earpiece headset with a flexible circuit board that can "fold upon itself or bend," which allows the circuit board to "fit in smaller or less traditionally-shaped earbuds." Appx5788–5789, ¶ [0130].

a. Ground 1(A)

Petitioner relied on Cooperstock's testimony that claim 1 would have been obvious under Ground 1(A). Cooperstock testified that a POSITA at the time of the '982 Patent's critical date would have had the same minimum skill level that a POSITA would have for the '325 Patent, namely "at least a Bachelor's Degree in an academic area emphasizing electrical engineering, computer science, or a similar discipline, and at least two years of experience in wireless communications across short distance or local area networks," where "[s]uperior education could compensate for a deficiency in work experience, and vice-versa." Appx5529, ¶ 30; Appx71. Koss agreed that is an appropriate POSITA skill level and the Board adopted this POSITA skill level in the FWD. Appx72; *see also* Appx4662 (Board adopting the same POSITA skill level in the Institution Decision).

Under this standard, a POSITA can have merely a bachelor's degree in computer science and two years of experience in short-distance wireless communication or local area networks, with no skills or experience specific to sound engineering or wireless headphone technology (hereinafter referred to below as the "Baseline POSITA" for the '982 Patent). While electrical engineering and computer science may provide context for certain underlying principles related to circuitry and signal transmissions, these academic disciplines do not specifically pertain to acoustics, wireless headphones, or even wireless speakers. Appx8829

(McAlexander Dec.), ¶ 20. Similarly, two years of experience with short-distance wireless communications or local area networks would also not necessarily involve acoustics, wireless headphones, or wireless speakers. *Id*. Importantly, among the skills that Cooperstock did not identify that a POSITA for the '982 Patent would necessarily have are skills or experience related to designing the acoustic transducer for a wireless earphone, fitting all of the components into a small form factor earphone, and powering the device in a manner suitable for a wireless earphone.

Cooperstock's skill level far exceeds the Baseline POSITA. Cooperstock earned a Ph.D. in electrical and computer engineering in 1996. Appx5516, ¶ 7. He also has over 25 years of industry experience. Appx5516–5518, ¶¶ 8–11; Appx5632–5637. Cooperstock, however, could not explain how many of the components in Rosener's and Hankey's headsets operate, including components that are critical to constructing operative wireless earphones. For example, Rosener's earphones include a speaker (or "transducer element"), which Rosener explains could be "a magnetic element attached to a voice-coil-actuated diaphragm, an electrostatically charged diaphragm, a balanced armature driver, or a combination of one or more of these transducer elements." Appx1419–1420, ¶ [0030]. Yet Cooperstock, who has skills superior to the Baseline POSITA, could not explain how the speaker elements disclosed in Rosener operate or even how

they compare to one another. Appx8716–8722. However, according to McAlexander, to design and construct operative wireless earphones, the designer would need to select the appropriate transducer design given the sound quality and earphone form factor considerations. Appx8846, ¶ 50.

Rosener's earphones also include a data buffer and an A/D converter, and Rosener explains several ways "to compensate for differential latencies between" the data streams for the two independently wireless earphones. Appx1420–1421, ¶¶ [0037]–[0039]. Cooperstock provided puzzling testimony about how these components operate. Cooperstock testified that Rosener's A/D converter "take[s] samples out of" the data buffer and "consumes" the data samples in the data buffer. Appx8725, ll. 3–6 ("my understanding is that an A/D converter that is connected to a buffer will take samples out of that buffer"); *id.*, ll. 6–9 (A/D converter is "taking samples out of" the data buffer and "passing it on to the next stage in the circuit"); Appx8729, ll. 3–6 ("my understanding is that if there's an A/D converter that is consuming content from the buffer, that means the buffer is holding analog information or analog data").

McAlexander interpreted Rosener differently. According to McAlexander, Rosener's A/D converter samples (after some processing) the received analog signal. Appx8848, ¶ 54; *see also* Appx1421–1422 (Rosener), ¶ [0047]. McAlexander elaborated that an "A/D converter, by its very nature, converts an

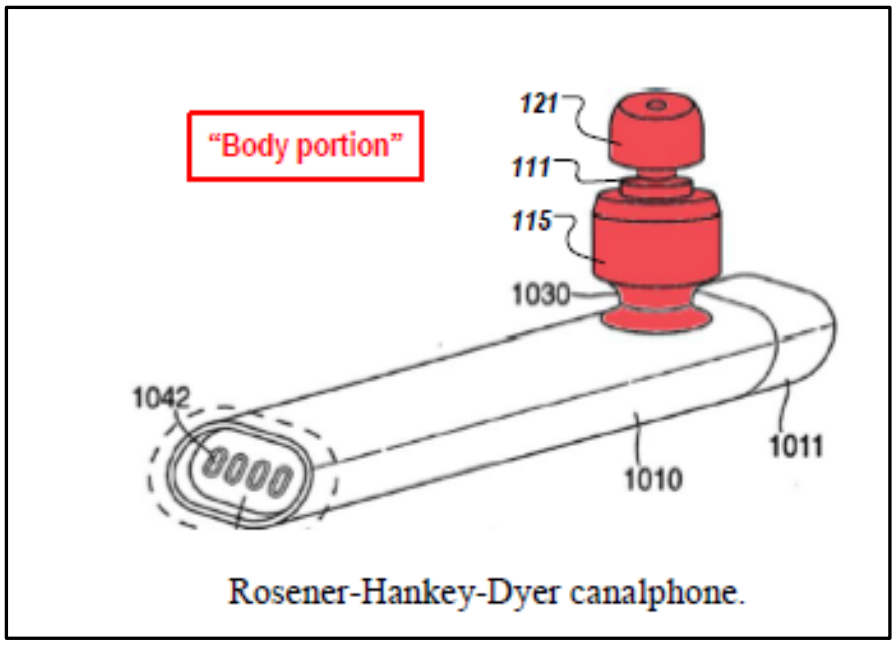
analog signal to digital values" so that it "makes sense, therefore, that the A/D converter would convert an input analog signal to digital values (i.e., data) for storage in the data buffer." Appx8848, ¶ 54. Thus, according to McAlexander, and in contrast to Cooperstock's understanding, Rosener's data buffers store the outputs of the corresponding A/D converter. *Id*. McAlexander's understanding is consistent with Rosener's disclosure. Rosener describes that if the A/D converter is too fast, the A/D converter will stall because it will run out of data faster than data are provided to it. Appx1420, ¶ [0038]. Thus, with a fast A/D converter, there will be fewer digitized samples to store in the data buffer (because the A/D converter will have stalled), so Rosener proposes techniques (interpolated or repeated data samples) to replenish the data buffer. Appx1421, ¶ [0039]. That suggests, according to McAlexander's testimony, that the output of the A/D converter (i.e., digitized samples) is input to the data buffer for storage (Appx8849, ¶ 55), which is the opposite of Cooperstock's testimony about how Rosener operates.

McAlexander also testified that claim 1 would not have been obvious under Ground 1(A) because the Rosener–Hankey "modification would require superior skills in audio electronics far beyond those of the applicable POSITA," including "specific knowledge of the individual transducer elements, signal processing, and data buffering disclosed by Rosener and Hankey, as well as a specific knowledge as

to how such components are integrated into small form factor wireless headphones that provide an acceptable sound quality and a comfortable fit within the user's ear." Appx8843, ¶ 47.

b. Ground 1(A)(i)

Petitioner asserted Ground 1(A)(i), which includes Dyer in conjunction with Rosener and Hankey, "to the extent [Koss] claims that a POSITA would have required additional specificity as to the structure of the portion of the canalphone that is inserted into a user's ear …." Appx4460. Dyer discloses an "eartip" that is attachable to a "standard, generic earphone …." Appx5820, 2:22–23. Petitioner proposed a Rosener–Hankey–Dyer canalphone, reproduced below, for Ground 1(A)(i), where the composite canalphone includes the form factor of Hankey's earpiece (primary housing 1010 and neck 1030) with additional components from Dyer's earphone—namely, the sub-enclosure 115, sound delivery member 111, and eartip 121. Appx4467; Appx5578, ¶ 97.



Rosener-Hankey-Dyer canalphone.

Blair, however, testified that the "Rosener-Hankey-Dyer canalphone would not stay in a user's ear" because the "canalphone does not include an adequate securing mechanism, and the 'body portion' thereof forms an extended cantilevered arm between the in-ear portion of the canalphone and the primary housing 1010, which would generate a significant torque at the in-ear portion from the offset weight of the primary housing." Appx8921–8922, ¶ 20. This "torque would cause user discomfort as the canalphone is rotated upward away from the lower surface of the concha and would likely dislodge the canalphone from the user's ear." Appx8922, ¶ 20. In light of this testimony, McAlexander opined that a "POSITA would likely understand that the combination of Rosener-Hankey-Dyer, as proposed by Petitioner, would not be mechanically feasible and thus, a POSITA would not be motivated to modify Rosener in view of Hankey and Dyer

to make the combination proposed in the Petition." Appx8851, ¶ 59.

2. Final Written Decision

The Board found that Petitioner proved by a preponderance of evidence that challenged claims 1–5 and 14–18 are unpatentable under § 103, and that Petitioner failed to prove that challenged claims 19 and 20 are unpatentable. Appx62. The Board rejected Koss's argument that a POSITA could not reasonably make the proposed combinations for Grounds 1(A) and 1(A)(i), as evidenced by Cooperstock's inability to understand important concepts in the relied-upon references (Rosener and Hankey) and Cooperstock's superior skill level compared to the minimum skill level for a POSITA for the '982 Patent. Appx84–87.

The Board rejected Koss's "complexity arguments" because, according to the Board, they were "predicated on bodily incorporation," which is "not the test for obviousness." Appx86. The Board found that "design and implementation details of the headphones would have been well-known," that "the properties, characteristics, and use of audio transducers … were all well-known by the Critical Date," and that "materials for the flexible electrical connectors were also well-known by the Critical Date." *Id*. Citing *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994), the Board concluded that if a POSITA "could make the invention described and claimed in the '982 Patent, the combination would likewise be made based on the same level of disclosure in Rosener." Appx87. In that connection,

the Board found that the "claims do not include limitations regarding design and operability" such that the Board's inquiry was limited to "what the combined teachings of the references would have suggested to" a Baseline POSITA. Appx87. The Board was "not persuaded that the design and operational issues raised by [Koss] would have precluded a [POSITA] from understanding the references and any differences between the references and claim 1." Appx88; *see also* Appx91 ("We find Hankey's small form factor wirelessly connected earpieces resolve the problems identified by Rosener …").

With respect to Ground 1(A)(i), the Board gave neither expert conclusive weight on the design issues presented by Dyer's canalphone. Appx92. However, the Board found that a POSITA "would have recognized that Rosener's disclosure of a canalphone could be implemented in the Rosener-Hankey combination as advanced in the Petition to provide a superior securing mechanism than an earphone configuration, like that disclosed in Hankey." *Id.* (citing Appx4849). The Board found Blair's testimony inconclusive on this point. Appx92.

The Board also concluded that Petitioner proved by a preponderance of the evidence that dependent claims 2–5 and 14–18 are unpatentable under § 103 (Appx103–104; Appx109–127), but that Petitioner failed to prove that dependent claims 19 and 20 are unpatentable. Appx104–109.

IV. INTERVENTION BY THE DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

This Court granted Koss's unopposed motion to withdraw Petitioner as a party to this consolidated appeal. *See* Case No. 2022–2091, Dkt. No. 11 (Fed. Cir. Sept. 2, 2022). Thereafter, the Director of the United States Patent and Trademark Office intervened. *Id.*, Dkt. No. 13 (Fed. Cir. Sept. 19, 2022).

SUMMARY OF ARGUMENT

I. The Board erred finding that Petitioner proved by a preponderance of the evidence that claims 1–4, 9, 10, and 14–17 of the '325 Patent are unpatentable under 35 U.S.C. § 103. No substantial evidence supports the Board's decision because no reasonable mind would accept as adequate the Board's reasoning that Rosener's ¶ [0030] expressly discloses the "hanger bar" wireless earphone form factor of claim 1 of the '325 Patent. That error was not harmless because the evidence of record fails to prove that the form factor of claim 1 would have been obvious in view of Rosener (or the other references cited by Petitioner against claim 1). Specifically, as explained by one of Koss's witnesses, Blair, the modified Figure 5 earphones of Rosener relied upon by Petitioner would have had resulting forces that would have pried the earphones out of the user's ears. The Board's finding that Rosener's ¶ [0030] expressly discloses the "hanger bar" wireless earphone form factor of claim 1 of the '325 Patent precluded the Board from considering the merits of Blair's testimony.

II. The Board made both non-harmless legal conclusions and factual findings with respect to claim 1 of the '982 Patent. The Board's non-harmless legal error was its reliance on *In re Keller*, 642 F.2d 413 (C.C.P.A. 1981) to reject Koss's "complexity arguments" showing the patentability of claim 1 as being improperly "predicated on bodily incorporation." Appx86. Koss, however, did not

make any bodily incorporation argument. Koss's argument was that the undisputed evidence showed that a POSITA, and particularly a Baseline POSITA, could not arrive at the subject matter of claim 1 in view of the relied-upon references for Grounds 1(A) and 1(A)(i) because the concepts involved were beyond the skill level of a Baseline POSITA, as evidenced by the testimony from each party's expert. The Board's non-harmless factual findings include (i) that Rosener has the same level of disclosure as the '982 Patent, and (ii) that the challenged claims "do not include limitations regarding design and operability." Appx87. To the contrary, Rosener does not have the same level of disclosure as the '982 Patent specification, thereby making the Board's reliance on *In re Epstein*, 32 F.3d 1559 (Fed. Cir. 1994) misplaced. The '982 Patent specification has important enabling disclosures about the earphone form factor of claim 1 that Rosener does not possess, including the use of a single integrated circuit, such as an SOC, for the earphones' internal electronics. Appx188, 6:49–54. Also, contrary to another factual finding of the Board, the challenged claims undisputedly include limitations regarding design and operability of the wireless earphones. The Board's legal errors were not harmless because Petitioner failed to show that claim 1 is unpatentable when Koss's evidence is considered.

ARGUMENT

I. STANDARD OF REVIEW

Obviousness is a legal question based on underlying findings of fact. *Univ. of Strathclyde v. Clear-Vu Lighting LLC*, 17 F.4th 155, 160 (Fed. Cir. 2021). This Court reviews the Board's ultimate obviousness determination *de novo* and underlying factual findings for substantial evidence. *LG Elecs. Inc. v. Immervision, Inc.*, 39 F.4th 1364, 1371 (Fed. Cir. 2022). Legal conclusions are those reached by the application of the law to a given set of facts, and under a *de novo* standard of review, this Court gives no deference to legal conclusions of the Board. *Kamstrup A/S v. Axioma Metering UAB*, 43 F.4th 1374, 1380 (Fed. Cir. 2022) (legal conclusions reviewed *de novo*). For the Board's underlying factual findings, substantial evidence is "something less than the weight of the evidence but more than a mere scintilla of evidence," meaning that "[i]t is such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *In re NuVasive, Inc.*, 842 F.3d 1376, 1379–80 (Fed. Cir. 2016) (internal quotation marks omitted).

II. NO SUBSTANTIAL EVIDENCE SUPPORTS THE BOARD'S DETERMINATION THAT CLAIMS 1–4, 9, 10, AND 14–17 OF THE '325 PATENT ARE UNPATENTABLE

Independent claim 1 of the '325 Patent recites that each earphone in the pair comprises (i) a body portion, (ii) an earbud extending from the body portion that is

inserted into the user's ear when worn by the user, and (iii) a curved hanger bar connected to the body portion. Appx165, 18:11–19; Appx9. In finding that claim 1 of the '325 Patent would have been obvious, the Board concluded that "Rosener expressly describes earbuds with curved hanger bars" such that the Board did not need to "evaluate which of the experts' views on the various forces of a Figure 4/5 combination would have been correct." Appx23. The Board also "s[aw] no description in Rosener that would limit Rosener's clip or earloop to only some earphone form factors" and "specifically [found] that Rosener's description of an earloop helping maintain the earphone 'on the ear of the user' … is not an attempt to exclude earbuds." Appx24.

No reasonable mind would accept this reasoning as adequate because Rosener does not expressly disclose the hanger bar form factor earphones recited in claim 1. Even if the Board's finding that Rosener does not limit Rosener's clip or earloop to certain form factors is given deference, Rosener does not disclose the hanger bar form factor of claim 1. The Board's error in finding that Rosener expressly discloses the form factor of claim 1 was not harmless, because, without Rosener expressly disclosing the earbud form factor of claim 1, the operative question becomes whether that earbud form factor would have been obvious in view of Rosener (and/or Hankey and/or Dyer). That question implicates the experts' views on the feasibility of Petitioner's modified Figure 5 earphones, and

Blair's testimony on this issue is significantly more compelling than Cooperstock's testimony given Blair's expertise on the issue.

A. A Reasonable Mind Would Not Accept That Rosener Expressly Discloses the Earbud Form Factor of Claim 1

The Board relied on Rosener's ¶ [0030] to conclude that Rosener expressly teaches the earphone form factor of claim 1. Appx23–24. However, the Board's interpretation of ¶ [0030] is misplaced, and no reasonable mind would accept it.

Rosener's ¶ [0030] begins by referencing Figure 5, which shows wireless earphones with a housing (or body portion) and an earbud, but no hanger bar or earloop. Appx1419; Appx1408. After describing the earphones depicted in Figure 5, Rosener's ¶ [0030] states that the earphone could have a variety of form factors, i.e., "an earbud designed to fit into the concha of the pinna of the user's ear; a canalphone, which can be fitted within the ear canal of the user's ear; an over-the-ear circum-aural type headphone; or any other suitable configuration that may be attached to, worn on, or fitted within the user's ear." Appx1419. It is undisputed that an over-the-ear circum-aural type headphone does not have an earbud that is inserted into the user's ear. Appx4067, ¶ 42; Appx2942 (an over-the-ear circum-aural headphone is a "headphone that is worn around the ear and fully encompasses the ear"). To that end, according to this sentence, the earbud and canalphone form factors fit "into" or "within" the user's ear, whereas the over-the-ear circum-aural type headphone does not because it does not have an earbud.

The immediately next sentence in ¶ [0030] states that each of the earphones "may further include a clip, earloop, or other suitable securing mechanism to help maintain the earphone … on the ear of the user." Appx1420. Thus, according to Rosener, the clip or earloop is for maintaining the earphone "***on***" the user's ear, which is in contrast to the earbud and canalphone form factor types, which are, according to Rosener, fitted "into" or "within" the user's ear. Thus, neither the earbud nor canalphone form factor type would include a clip or an earloop according to Rosener, which reserves the clip or earloop for use with over-the-ear circum-aural earphones that are "on" the user's ear.

A reasonable person would accept this interpretation of ¶ [0030] because it is consistent with the remainder of Rosener. The only earphone shown in Rosener with an earloop is Rosener's Figure 4, which shows an over-the-ear circum-aural earphone, not an earbud or a canalphone. Appx1407. Rosener explicitly characterizes the headset shown in Figure 4 of Rosener as an "over-the-ear wireless headset" that is "configured to fit around the outer ear of the user …." Appx1418, ¶ [0008]; *see also* Appx4067, ¶ 43. This teaching is consistent with the form factor teachings in Rosener's ¶ [0030]: only over-the-ear (or "circum-aural") earphones, which do not have an earbud, could include the earloop according to Rosener.

Consequently, Rosener does not expressly disclose the form factor of claim

1 and no reasonable mind would conclude that it does. Rosener only discloses over-the-ear circum-aural earphones as potentially having earloops, and over-the-ear circum-aural earphones do not comprise an earbud as required by claim 1. Appx4067, ¶ 42; Appx2942 (an over-the-ear circum-aural headphone is a "headphone that is worn around the ear and fully encompasses the ear").

B. The Evidence Fails to Show That It Would Have Been Obvious to Add Earloops to the Earphones Shown in Rosener's Figure 5

The Board's erroneous determination that Rosener expressly discloses the form factor of claim 1 was not harmless because the form factor of claim 1 also would not have been obvious in view of Rosener (and/or Hankey and/or Dyer). The Petitioner's sole theory for asserting that claim 1's form factor would have been obvious in view of Rosener was Petitioner's modified Figure 5 of Rosener (reproduced above; *see also* Appx21). Whether the modified Figure 5 shows the obviousness of claim 1 implicates the competing testimony of the parties' experts on the feasibility of the earphones shown in the modified Figure 5, which the Board did not evaluate. Appx23. The evidence, in the form of the testimony of Blair, whose career is devoted to developing earphones, overwhelmingly demonstrates that the modified Figure 5 earphones are not practical and would not have been obvious.

Blair testified that adding an earloop to an earphone with an earbud and a downwardly extending member, as shown in Rosener's Figure 5, would counteract

the securing forces of the earbud-downwardly extending member earphone and actually work to pry the earbud out of the user's concha. Appx4135–4136, ¶ 16. Blair explained that, with respect to the earphones depicted in Rosener's Figure 5, "the downwardly-extending member for each earphone is intended to extend through the intratragal notch of the user's ear.… The weight of the downwardly-extending member serves to keep the earbud seated on the lower portion of the concha of the user's ear so that the earbud tends to stay on (or secured in) the user's ear." Appx4131–4132, ¶ 12.[3] The earloop in Rosener's Figure 4 also exerts a force acting on the earphone to hold it in place. Appx4133, ¶ 14. However, such force is exerted toward the back of the ear (i.e., in the opposite direction of the boom mic that would be extending to the user's mouth). *Id.* If the two securing mechanisms were combined—that is, the earloop combined with the earbud-downwardly extending member of Rosener's Figure 5—the result would be a force that "extends in a direction that would tend to displace the in-ear portion of the earbud out of the concha, displace the downwardly-projecting member out of the intratragal notch, and/or displace the earloop from around the user's ear. In effect, the ***resultant force would essentially pry the earbud out of the concha***, which

[3] Blair described the "intratragal notch" and other components of the human ear at Appx4128, ¶ 7.

would lessen the sound quality characteristics of the earbud and result in earphones that are uncomfortable for the user." Appx4135–4136, ¶ 16 (emphasis added).

Blair's testimony is supported by Rosener, because Rosener only depicts an earloop with the over-the-ear earphone of Rosener's Figure 4, and the earloop, according to Blair, is intended to support the headphone in a position near the user's ear, while balancing the torque from the boom mic (element 406 in Rosener's Fig. 4), so that the headphone is in an orientation that adequately directs a sound emitted from the user's mouth to the boom mic. Appx4129, ¶ 9. The earbuds shown in Rosener's Figure 5 do not include an extended boom mic or an earloop (Appx1408) and a POSITA would not add an earloop to the earbud-downwardly extending member depicted in Rosener's Figure 5, as shown in Petitioner's modified Figure 5. Appx4067, ¶ 43.

The soundness of Blair's testimony, given his extensive and relevant experience, is evidenced by the fact that Petitioner chose not to depose him. Instead, Petitioner proffered more testimony from Cooperstock in an attempt to refute Blair's testimony. No reasonable person, however, would accept Cooperstock's testimony over Blair's. Cooperstock does not possess any meaningful earphone design and/or development experience. In stark contrast to Blair's experience, Cooperstock has only designed a single pair of earphones in the "early 1970s." Appx4260–4261. The earphones designed by Cooperstock fifty

years ago were "fairly simple, using existing components of speakers, wires, [and] power supply," not wireless, and not commercially sold. Appx4261. Cooperstock also does not have any patents on headphones, whereas Blair has several. Appx4261; Appx4127, ¶ 5. Cooperstock's minimal experience in earphone design and development pales in comparison to the experience of Blair. As such, no reasonable mind would accept Cooperstock's testimony relating to earphone design and development considerations over Blair's testimony.

The Board characterized Petitioner's modified Figure 5 as an "illustration of how these expressly described features" in Rosener "might look together, as Rosener does not have a figure depicting" a pair of independently wireless earphones with earloops and, in that connection, the Board did not read the modified figure "as a proposed physical combination of different embodiments within Rosener." Appx23. This finding by the Board is irrelevant and, in any event, wrong. It is irrelevant because the Board found that Rosener "expressly teaches" the form factor of claim 1 (Appx24) and no reasonable mind would accept that conclusion as described above. The Board's finding is wrong because Petitioner did not characterize its modified Figure 5 as a mere illustration. Instead, Petitioner characterized it as "a modified version of Figure 5 showing a configuration of earphones 502, 504 including the earloops disclosed in Rosener …," (Appx242; *see also* Appx1295, ¶ 84), without providing any other version and

without explaining that the modified Figure 5 was a mere illustration or example.

Finally, below Petitioner relied on Kim (Appx3192–3199) and Jabra Talk 5 (Appx3200–3201) to prove, allegedly, that Petitioner's modified Rosener earphones had been implemented by others, thereby rebutting, allegedly, Blair's testimony that the Petitioner's proposed modified Rosener earphones would not work. The Board's Final Written Decision did not rely on either Kim or Jabra Talk 5 for the clear reason that neither Kim nor Jabra Talk 5 is similar to Petitioner's modified Figure 5 earphones. In both Kim and Jabra Talk 5, the alleged "body portions" have "offset" portions that extend upwardly past the earbud. Appx3194; APPLE–1027; Appx3200–3201, Appx4284 (Cooperstock testifying that in Kim "the earbud is offset along the long axis of the elongated portion of the body"); Appx4284–4285 (same); Appx4287 (same for Jabra Talk 5). Also, the earhooks in Kim and Jabra Talk 5 are connected in a middle portion of the elongated body portion and on the same side of the body portion as the earbud. Appx3194; Appx3200–3201.

C. Summary

No reasonable mind would accept as adequate the Board's determination that Rosener expressly describes earbuds with hanger bars. Even if the Board's finding that Rosener does not limit Rosener's clip or earloop to certain form factors is given deference, Rosener still does not expressly teach the earbud form factor of

claim 1 because Rosener only teaches earloops for over-the-ear circum-aural earphones that do not include an earbud. The Board's error in finding that Rosener expressly discloses the form factor of claim 1 was not harmless, because, without this finding, Petitioner failed to prove that the form factor of claim 1 would have been obvious. Thus, Petitioner failed to prove that independent claim 1, as well as claims 2−5, 9, 10, and 14−17 depending therefrom, would have been obvious.

III. THE BOARD MADE NON-HARMLESS LEGAL CONCLUSIONS AND FACTUAL FINDINGS IN CONCLUDING THAT PETITIONER PROVED THAT CLAIM 1 OF THE '982 PATENT IS UNPATENTABLE UNDER GROUNDS 1(A) AND 1(A)(i)

The Board found in Petitioner's favor that claim 1 of the '982 Patent is unpatentable under both Ground 1(A) (i.e., Rosener and Hankey) and Ground 1(A)(i) (i.e., Rosener, Hankey and Dyer). Appx80–103. The Board made both non-harmless errors of law, which are reviewed without deference, and non-harmless erroneous factual findings, which are reviewed for substantial evidence, in concluding that Petitioner proved that claim 1 would have been obvious under these asserted grounds. Accordingly, the Board's determinations for claim 1, as well as its challenged dependent claims (claims 2–5 and 14–18), should be reversed.

A. The Board Erred as a Matter of Law by Applying Inapposite Caselaw to the Relevant Facts

Koss argued below that claim 1 of the '982 Patent would not have been

obvious under Grounds 1(A) and 1(A)(i) because a Baseline POSITA (which qualifies as a POSITA according to the Board) could not arrive at the subject matter of claim 1 with a reasonable expectation of success in view of the cited references for Grounds 1(A) and 1(A)(i). Appx4735–4743 (Patent Owner Response); Appx4888–4894 (Patent Owner Sur-reply); *see also Eli Lilly and Co. v. Teva Pharms. Int'l GmbH*, 8 F.4th 1331, 1345 (Fed. Cir. 2021) (in order to prove that a claim would have been obvious, IPR petitioner "was required to show that a skilled artisan would have had a 'reasonable expectation' of success …"). Koss proved, via, among other things, Cooperstock's testimony, that there are numerous difficulties that a POSITA would have faced in making the proposed Rosener–Hankey and Rosener–Hankey–Dyer combinations. These difficulties include integrating an appropriate speaker (or transducer) into the small form factor earphones, selecting the appropriate material for the flexible connectors and circuits, and processing latencies in the audio streams for the two, independently wireless, earphones. *See* Appx8716–8722 (Cooperstock testimony on transducers); Appx8746 (Cooperstock testimony on material for flexible connectors); Appx8734–8736 (Cooperstock testimony on processing audio streams). Cooperstock exhibited a failure to understand the technical disclosures of Rosener and Hankey, including these concepts. Accordingly, a Baseline POSITA, with significantly less skill and relevant experience than Cooperstock,

would have little hope of understanding the concepts, let alone be able to combine the references as proposed. Moreover, the undisputed evidence shows that these concepts are critical to making operative wireless headphones. Appx8845–8850 (McAlexander), ¶¶ 49, 50, 52, 56. Thus, the undisputed evidence shows that some persons (e.g., Baseline POSITAs) that satisfy the applicable POSITA standard would not understand important concepts that are required to make the claimed earphones.

The Board rejected Koss's arguments because they "are predicated on bodily incorporation," citing *In re Keller*, 642 F.2d 412, 425 (C.C.P.A. 1981). *In re Keller*, however, is not applicable here and the Board committed legal error by applying it to the facts at hand to discount Koss's compelling evidence that claim 1 would not have been obvious.

In re Keller stands for the proposition that "[t]o justify combining reference teachings in support of a rejection it is not necessary that a device shown in one reference can be physically inserted into the device shown in the other." 642 F.2d at 425. The applicant's patent application in *In re Keller* involved a pacemaker with a digital counter. *Id.* at 415. The prior art showed both (i) pacemakers with analog circuits (e.g., Keller) and (ii) a stimulator driving unit for the controlled stimulation of a heart with a digital timing circuit (Walsh). *Id.* at 418–420. The examiner rejected the claims because providing a digital timing circuit as in Walsh

for the analog equivalent in Keller "amounts to an obvious substitution" for the applicable POSITA. *Id.* at 421. The applicant argued that there was no motivation to incorporate Walsh's digital timing circuit into Keller's pacemakers, but both the Board of Appeals and the Court of Customs and Patent Appeals rejected the applicant's argument because the "test for obviousness is not whether the features of a secondary reference [e.g., Walsh] may be bodily incorporated into the structure of the primary reference [e.g., Keller]." *Id.* at 422–425.

The "bodily incorporation" doctrine of *In re Keller* is not applicable here and the Board committed legal error by applying the doctrine to the facts at hand. While Petitioner's invalidity theory arguably was that the flexible connectors of the secondary reference, Hankey, could be incorporated into the earphones of the primary reference, Rosener, Koss did not argue that the cited references lacked an express motivation to make the incorporation. Instead, Koss argued that the alleged combination of Rosener was beyond the skill level of a POSITA, which inherently includes a Baseline POSITA. As described above, even a highly skilled POSITA like Cooperstock did not understand components that are critical to making an operative wireless earphone, such as the speaker, the flexible connectors to realize a small form factor for the earphone, and the components that account for differential latencies in the data streams to the two, independently wireless, earphones. Thus, *In re Keller* is inapposite and the Board committed legal error by

applying it here to discount Koss's evidence that claim 1 would not have been obvious.

B. No Substantial Evidence Supports the Board's Factual Findings

In addition to the above-described legal error, the Board made erroneous factual findings in concluding that Petitioner proved that claim 1 would have been obvious. The first erroneous factual finding was that Rosener includes the "same level of disclosure" as the '982 Patent specification. Appx87. The Board relied on this finding to apply *In re Epstein*, 32 F.3d 1559 (Fed. Cir. 1994) to discount Cooperstock's testimony that proves the patentability of claim 1. Appx87. The second erroneous factual finding was that claim 1 does "not include limitations regarding design and operability." *Id.* No substantial evidence supports either of these findings.

In re Epstein stands for the proposition that a prior art reference is enabling if it has at least the same level of disclosure as the specification of the patent or application in question. 32 F.3d at 1568. The Board applied *In re Epstein* because, according to the Board, the '982 Patent has the "same level of disclosure" as Rosener. Appx87. This represents an erroneous factual finding because Rosener does not have the same level of disclosure as the '982 Patent and no reasonable person would accept that these disclosures are at the same level. The '982 Patent provides explicit disclosures that are not included in Rosener for how to make

small form factor wireless earphones, such as recited in claim 1. Namely, the '982 Patent provides explicit disclosures for integrating the wireless earphones' electronics into a single integrated circuit, such as a SOC, "which is conducive to miniaturizing the components of the earphone, which is advantageous if the earphone is to be relatively small in size, such as an in-ear earphone," such as the wireless earphone shown in Figure 1B of the '982 Patent, which is the focus of claim 1. Appx188, 6:49–54 (reference numbers omitted). Rosener has no such similar disclosure. It is undisputed that Rosener does not disclose how to miniaturize the components of Rosener's wireless earphones into a small form factor. Petitioner acknowledged that Rosener is "silent as to the implementation details of arranging Rosener's electrical components within the compact form factor of each of the earphones" shown in Rosener's Figure 5 and that Rosener "contains only a limited disclosure of the details of the earphones' form factor." Appx4456 (citing Appx5543 (Cooperstock Opening Dec.), ¶ 45). Thus, it is undisputed that Rosener's disclosure is not at the same level as the '982 Patent.

It is immaterial that Hankey's headset can include a SOC. Appx5786, ¶¶ [0103]–[0105], [0176]. Hankey is Petitioner's secondary reference in Grounds 1(A) and 1(A)(i). The Board applied *In re Epstein* to the primary reference, Rosener, for those asserted grounds. Appx87. Also, the compatibility of Hankey's SOC to Rosener was not litigated in the IPR. Neither Petitioner, Cooperstock, nor

the Board relied on or cited Hankey's SOC and, with respect to the '982 Patent's disclosure to use a SOC, the Petitioner only asserted that the challenged claims do not recite an SOC (Appx4852–4853), which misses the mark that *In re Epstein* focuses on the disclosures, not the claims. *In re Epstein*, 32 F.3d at 1568 (focusing on detail in applicant's specification, not the pending claims).

The Board's finding that the challenged claims "do not include limitations regarding design and operability" (Appx87) was also erroneous. Claim 1 of the '982 Patent recites a specific earphone form factor design, i.e., wireless earphones with a body portion with an "ear canal portion" and with "an elongated portion" extending downwardly away from the body portion, where the body portion also comprises the wireless communication circuit, the processor circuit, and the speaker (i.e., "at least one acoustic transducer"). Appx194, 18:16–24. Further, Petitioner never challenged, or even questioned, the operability of the system of claim 1, including how each earphone can "receive and play audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player." *Id.*, 18:36–40. Thus, no substantial evidence supports the Board's factual finding that the claims "do not include limitations regarding design and operability." *See also In re Antor Media Corp.*, 689 F.3d 1282, 1287 (Fed. Cir. 2012) (claims in a patent are presumptively enabling).

C. The Board's Errors Were Not Harmless

The Board's erroneous legal conclusions and factual findings were not harmless. The Board's relied on its erroneous legal conclusions and factual findings to reject Koss's "complexity arguments" that countered Petitioner's invalidity grounds. Appx86. Only by discounting Koss's evidence, including Cooperstock's testimony about the complexities involved, was the Board able to conclude that it was "not persuaded that the design and operational issues raised by [Koss] would have precluded a [POSITA] from understanding the references and any differences between the references and claim 1." Appx88; *see also* Appx91 ("We find Hankey's small form factor wirelessly connected earpieces resolve the problems identified by Rosener …"). If the Board had considered Cooperstock's testimony instead of ignoring it due to its erroneous applications of *In re Keller* and *In re Epstein*, the Board would have reached a different result. When Cooperstock's testimony is considered, it is clear that claim 1 is beyond the reach of a Baseline POSITA. The testimony from each party's experts shows that important concepts for making an operative wireless earphone were beyond the reason of a POSITA, particularly a Baseline POSITA.

The Board also found that claim 1 would have been obvious because each of the claim limitations was well known. The Board found that "design and implementation details of the headphones would have been well-known," that "the

properties, characteristics, and use of audio transducers … were all well-known by the Critical Date," and that "materials for the flexible electrical connectors were also well-known by the Critical Date." *Id.* Based on those findings, and the Board's conclusion that the claims "do not include limitations regarding design and operability," the Board found the claims obvious. Appx86–88.

However, obviousness is not judged based on whether the individual components of claim 1 were well known. *See Fromson v. Advance Offset Plate, Inc.*, 755 F.2d 1549, 1556 (Fed. Cir. 1985) ("no basis in the law … for treating combinations of old elements differently in determining patentability"); *Smiths Indus. Med. Systems, Inc. v. Vital Signs, Inc.*, 183 F.3d 1347, 1356 (Fed. Cir. 1999) (reversing district court decision on invalidity where all the claim limitations were "probably found in the prior art"). Instead, obviousness is judged based on whether the claimed invention would have been obvious to the applicable POSITA. 35 U.S.C. § 103; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 420 (2007) (question is "whether the combination was obvious to a person with ordinary skill in the art"). Here, even though the elements of claim 1 might have been known individually, the testimony from both experts shows that the applicable POSITA, particularly a Baseline POSITA, could not arrive at claim 1 with a reasonable expectation of success.

Upon considering the capabilities of a POSITA, McAlexander opined that

"the proposed modification would require detailed knowledge of and experience with the components utilized by the wireless headsets disclosed in Rosener and Hankey, beyond the capabilities of a POSITA." Appx8844, ¶ 47. Notably, "Cooperstock, with his superior skills and knowledge to that of a POSITA, exhibited a failure to accurately understand the technical disclosure of Rosener and Hankey that are critical to designing a wireless earphone and making the combinations proposed by Petitioner." Appx8845, ¶ 49. Among other shortcomings, Cooperstock was unable to: provide details relating to the functionality and implementation of Rosener transducers (Appx8716–8720); provide a technologically sound interpretation of the analog-to-digital converter and buffer of Rosener (Appx8725; Appx8729; Appx8739); and provide a suitable material for the flexible electrical connector in the proposed combination (Appx8740-8741). It would be evident to a reasonable mind that the Petitioner and Cooperstock improperly used the claims "as a frame" and selected "naked parts of separate prior art references [] as a mosaic to recreate a facsimile of the claimed invention," without consideration of whether the defined POSITA could in fact make the combination. *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1552 (Fed. Cir. 1983). Consequently, when Koss's arguments are not rejected due to the Board's erroneous legal conclusions and factual findings, the evidence shows that claim 1 would not have been obvious under Grounds 1(A) and 1(A)(i).

D. The Board's Non-harmless Legal Errors Apply to Ground 1(A)(i)

Petitioner also asserted Ground 1(A)(i), which includes Dyer in conjunction with Rosener and Hankey, against claim 1 "to the extent [Koss] claims that a POSITA would have required additional specificity as to the structure of the portion of the canalphone that is inserted into a user's ear …." Appx4460; Appx88. Koss did not assert that claim 1 requires additional specificity as to the structure of the "ear canal portion" other than what is recited in claim 1. As such, Petitioner still relied on Hankey's flexible connectors for implementing Rosener's internal components in Ground 1(A)(i). Appx4466–4467. Thus, Dyer does not cure the deficiencies of Rosener and Hankey relative to claim 1 and, accordingly, the Board's erroneous legal conclusions and factual findings for Ground 1(A) apply equally to Ground 1(A)(i).

IV. CONCLUSION

Because the Board erred in invalidating claims 1–4, 9, 10, and 14–17 of the '325 Patent and claims 1–5 and 14–18 of the '982 Patent, this Court should reverse the Board's erroneous invalidation of those claims.

Dated: November 28, 2022

Respectfully submitted,

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ADDENDUM

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Paper 47
Entered: May 31, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

KOSS COPRORATION,
Patent Owner.

IPR2021-00305
Patent 10,506,325 B1

Before DAVID C. MCKONE, GREGG I. ANDERSON,
and NORMAN H. BEAMER, *Administrative Patent Judges*.

MCKONE, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background and Summary

Apple Inc. ("Petitioner") filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 1–4, 9, 10, and 14–18 of U.S. Patent No. 10,506,325 B1 (Ex. 1001, "the '325 patent"). Pet. 1. Koss Corp. ("Patent Owner") filed a Preliminary Response (Paper 9, "Prelim. Resp."). Pursuant to our authorization, Petitioner filed a Preliminary Reply (Paper 12) and Patent Owner filed a Preliminary Sur-Reply (Paper 13). Pursuant to 35 U.S.C. § 314, we instituted this proceeding. Paper 14 ("Dec.").

Patent Owner filed a Patent Owner's Response (Paper 20, "PO Resp."), Petitioner filed a Reply to the Patent Owner's Response (Paper 35, "Reply"), and Patent Owner filed a Sur-reply to the Reply (Paper 42, "Sur-reply"). An oral argument was held in this proceeding on March 3, 2022. Paper 46 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Decision is a final written decision under 35 U.S.C. § 318(a) as to the patentability of claims 1–4, 9, 10, and 14–18. Based on the record before us, Petitioner has proved, by a preponderance of the evidence, that claims 1–4, 9, 10, and 14–17 are unpatentable, but has not proved that claim 18 is unpatentable.

B. Related Matters

1. Lawsuits

Petitioner advises us that it is a defendant in a case filed by Patent Owner asserting the '325 patent in the United States District Court for the Western District of Texas ("Texas court") captioned *Koss Corp. v. Apple Inc.*, Case No. 6:20-cv-00665 (W.D. Tex.) ("Texas case"). Pet. 79; *see also* Paper 11, 1. Patent Owner identifies another three lawsuits where Patent

Owner is plaintiff and the '325 patent is asserted against other parties. Paper 11, 1. Patent Owner identifies two other cases involving the '325 patent, including one filed by Petitioner in the United States District Court for the Northern District of California captioned *Apple Inc. v. Koss Corp.*, Case No. 4:20-cv-05504 (N.D. Cal.). Paper 11, 1.

2. Inter Partes Review Proceedings

Patent Owner (Paper 11, 1–2; Paper 30, 1) lists the following *inter partes* review proceedings[1] challenging the '325 patent or patents related to the '325 patent:

Bose Corp. v. Koss Corp., IPR2021-00297, filed December 7, 2020, challenging U.S. Patent No. 10,368,155 B2;

Apple Inc. v. Koss Corp., IPR2021-00381, filed January 4, 2021, challenging U.S. Patent No. 10,491,982 B1;

Apple Inc. v. Koss Corp., IPR2021-00546, filed February 22, 2021, challenging U.S. Patent No. 10,206,025 B1;

Apple Inc. v. Koss Corp., IPR2021-00592, filed March 2, 2021, challenging U.S. Patent No. 10,469,934 B1;

Bose Corp. v. Koss Corp., IPR2021-00612, filed March 3, 2021, challenging U.S. Patent No. 10,206,025 B1;

Apple Inc. v. Koss Corp., IPR2021-00626, filed March 17, 2021, challenging U.S. Patent No. 10,206,025 B1;

Bose Corp. v. Koss Corp., IPR2021-00680, filed March 17, 2021, challenging U.S. Patent No. 10,469,934 B1, filed March 17, 2021;

[1] *Apple Inc. v. Koss Corp.*, IPR2021-00255, filed November 25, 2020, and *Apple Inc. v. Koss Corp.*, IPR2021-00600, filed March 7, 2021, both challenging U.S. Patent No. 10,298,451 B1 are also pending.

Apple Inc. v. Koss Corp., IPR2021-00679, filed March 22, 2021, challenging the '325 patent;

Apple Inc. v. Koss Corp., IPR2021-00686, filed March 22, 2021, challenging U.S. Patent No. 10,491,982 B1;

Apple Inc. v. Koss Corp., IPR2021-00693, filed March 23, 2021, challenging U.S. Patent No. 10,469,934 B1;

Apple Inc. v. Koss Corp., IPR2022-00053, filed October 15, 2021, challenging U.S. Patent No. 10,206,025 B1; and

Apple Inc. v. Koss Corp., IPR2022-00188, filed November 15, 2021, challenging U.S. Patent No. 10,469,934 B1.

C. The '325 Patent

The '325 patent describes wireless earphones or headphones. Ex. 1001, 2:3–5. Figure 1D, reproduced below, illustrates an example:

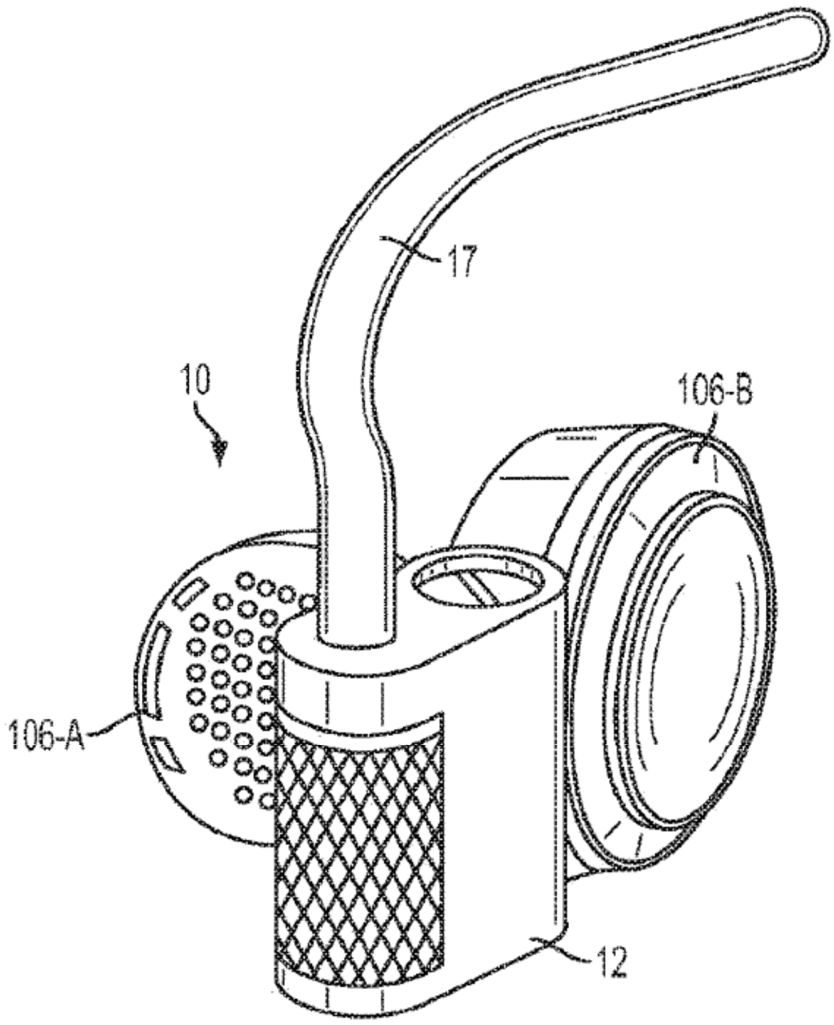

FIG. 1D

Figure 1D is a perspective drawing of a wireless earphone. *Id.* at 2:30–31, 4:7. In this embodiment, earphone 10 includes hanger bar 17 that allows earphone 10 to clip to, or hang on, a listener's ear. *Id.* at 4:4–7. Speaker element 106-A is sized to fit into the cavum concha of the listener. *Id.* at 4:10–12. Hanger bar 17 includes a horizontal section that rests upon the upper external curvature of the listener's ear behind the upper portion of the auricula (or pinna). *Id.* at 4:14–18.

Certain features of an embodiment of a wireless earphone are depicted in Figure 3, reproduced below:

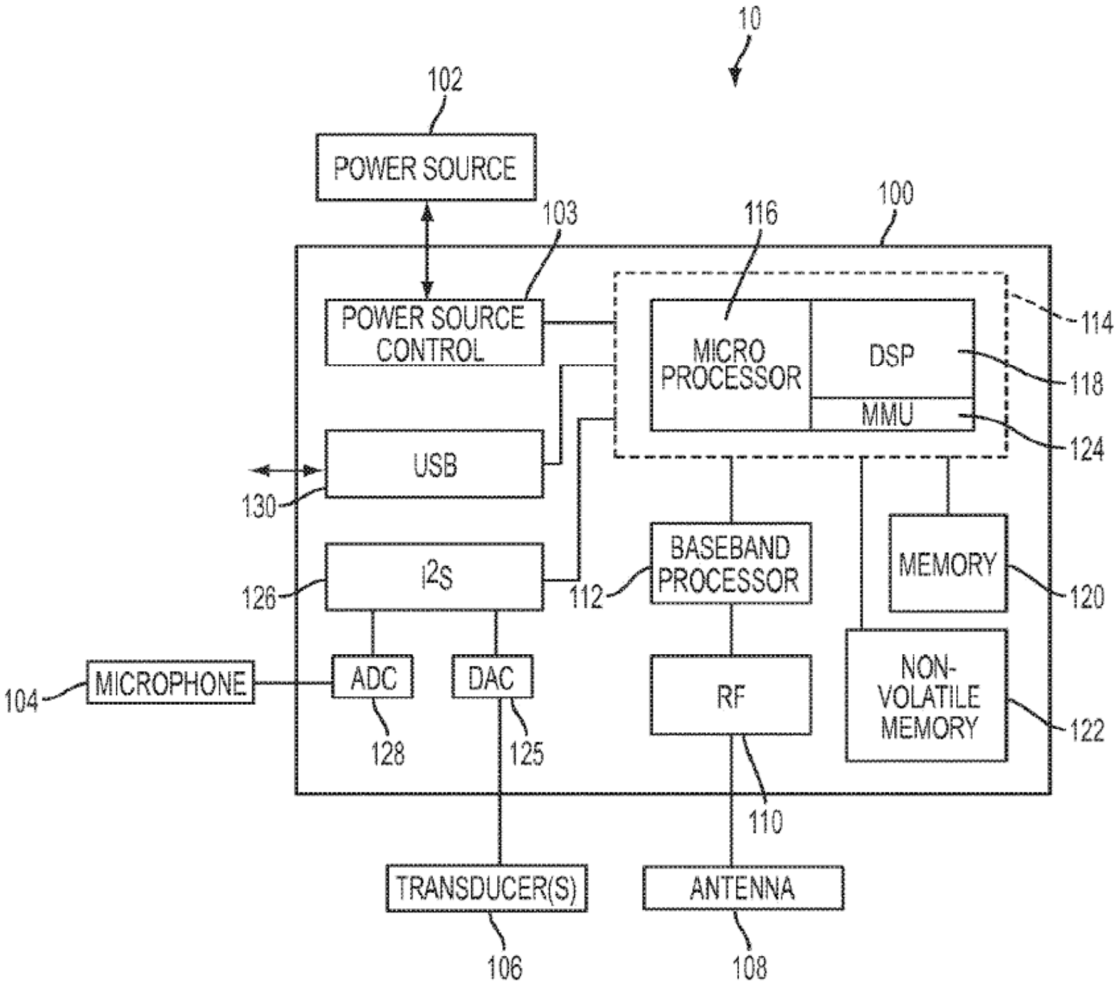

FIG. 3

Figure 3 is a block diagram of a wireless earphone. *Id.* at 2:35–36, 6:30–31.

Earphone 10 includes transceiver circuit 100, power source 102, microphone 104, acoustic transducer 106 (e.g., a speaker), and antenna 108. *Id.* at 6:31–37. Transceiver circuit 100, power source 102, and acoustic transducer 106 may be housed within body 12 of earphone 10 (shown in Fig. 1D above). *Id.* at 6:37–40. Microphone 104 and antenna 108 are external to body 12. *Id.* at 6:40–42. Earphone 10 incudes baseband processor 112 in communication with processor unit 114 which, in turn, includes microprocessor 116 and digital signal processor (DSP) 118. *Id.* at

7:30–32. DSP 118 "may . . . perform various sound quality enhancements to the digital audio received by the baseband processor 112, including noise cancellation and sound equalization." *Id.* at 7:34–38. Processor unit 114 executes firmware that may be stored on memory units 120, 122. *Id.* at 7:43–46. The '325 patent describes headphone 10 receiving firmware upgrades from a host server when earphone 10 is connected to a client computer device through a USB port and/or docking station. *Id.* at 9:50–56. "The power source 102 may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). . . . In embodiments where the power source 102 comprises a rechargeable battery cell . . ., the battery cell . . . may be charged for use, for example, when the earphone 10 is connected to a docking station or computer." *Id.* at 6:56–65.

Earphone 10 may interface with an external device, such as the docking station shown in Figure 4A, reproduced below:

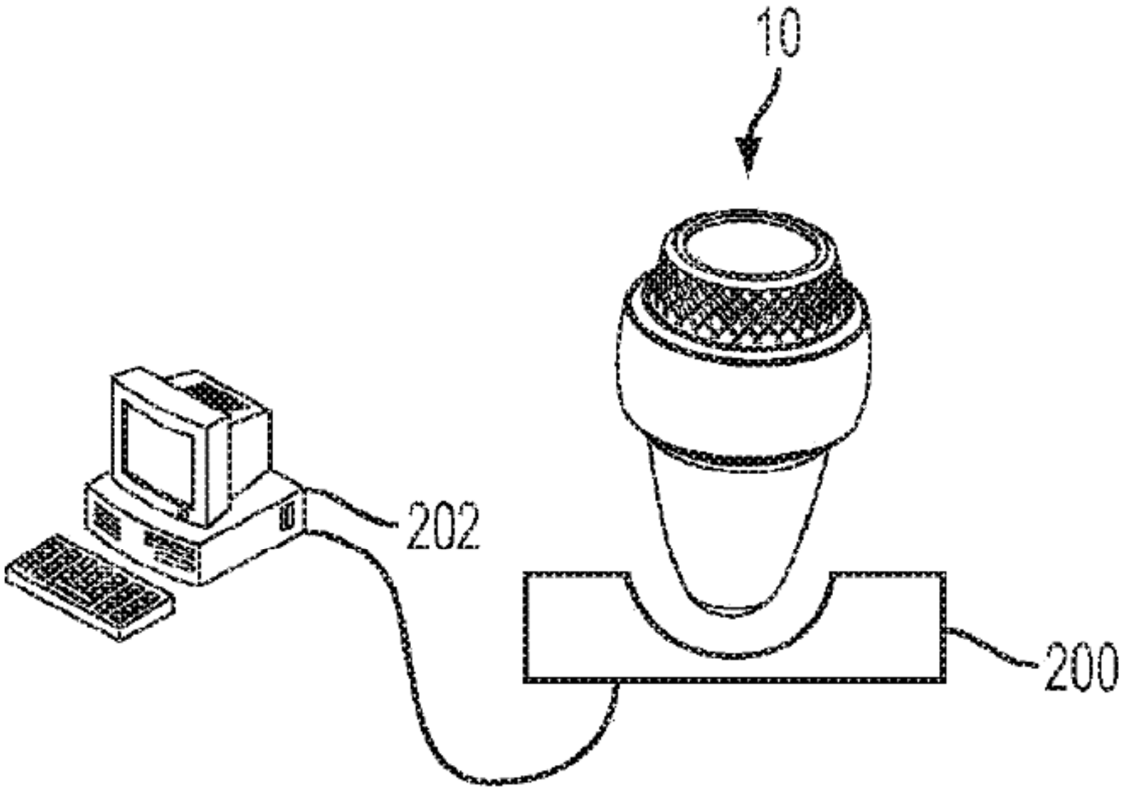

FIG. 4A

Figure 4A is a drawing showing earphone 10 interfacing with docking station 200, which is connected to computer device 202. *Id.* at 7:64–66. Earphone 10 may connect to docking station 102 to charge up power source 102 and to download data or firmware. *Id.* at 8:5–8.

Claims 1, 9, and 18, reproduced below, are illustrative of the claimed subject matter:

> 1. Headphones comprising:
>
> a pair of first and second wireless earphones to be worn simultaneously by a user, wherein the first and

second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected, wherein each of the first and second earphones comprises:

a body portion;

an earbud extending from the body portion that is inserted into an ear of the user when worn by the user;

a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user;

a wireless communication circuit for receiving and transmitting wireless signals;

a processor circuit connected to the wireless communication circuit;

at least one acoustic transducer for producing audible sound from the earbud;

a microphone for picking up utterances of a user of the headphones;

an antenna connected to the wireless communication circuit; and

a rechargeable power source; and

a docking station for holding at least the first wireless earphone, wherein the docking station comprises a power cable for connecting to an external device to power the docking station, and wherein the docking station is for charging at least the first wireless earphone when the first wireless earphone is placed in the docking station.

9. The headphones of claim 1, the processor circuits of the headphones are configured to receive firmware upgrades transmitted from a remote network server.

18. The headphones of claim 1, wherein the processor circuit of each of the first and second earphones comprises:

a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone; and

a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

D. Evidence

Petitioner relies on the references listed below.

Reference		Date	Exhibit No.
Rosener	US 2008/0076489 A1	pub. Mar. 27, 2008	1004
Huddart	US 7,627,289 B2	pub. Dec. 1, 2009 filed Dec. 23, 2005	1005
Haupt	WO 2006/042749 A2	pub. Apr. 27, 2006	1006[2]
Price	US 2006/0026304 A1	pub. Feb. 2, 2006	1008
Paulson	US 7,551,940 B2	iss. June 23, 2009 filed Jan. 8, 2004	1009
Vanderelli	US 7,027,311 B2	iss. Apr. 11, 2006	1010

Petitioner also relies on the Declaration of Jeremy Cooperstock, Ph.D. (Ex. 1003, "Cooperstock Decl."), and the Supplemental Declaration of Dr. Cooperstock (Ex. 1023, "Supp. Cooperstock Decl.").

[2] We refer to a certified translation of the German language publication of WO 2006/042749.

Patent Owner relies on the Declaration of Joseph C. McAlexander III (Ex. 2035, "McAlexander Decl.") and the Declaration of Nicholas S. Blair (Ex. 2036, "Blair Decl.").

E. The Asserted Grounds

We instituted on the following grounds of unpatentability (Dec. 9):

Reference(s)	Basis	Claims Challenged
Rosener, Huddart	§ 103(a)[3]	1, 2, 16–18
Rosener, Huddart, Haupt	§ 103(a)	3, 4
Rosener, Huddart, Price	§ 103(a)	9, 10, 14
Rosener, Huddart, Paulson	§ 103(a)	15
Rosener, Huddart, Vanderelli	§ 103(a)	16, 17

II. ANALYSIS

A. Claim Construction

We construe a claim

> using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

37 C.F.R. § 42.100(b) (2019); *see also Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

[3] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 103. Because the '325 patent claims an effective filing date before March 16, 2013, the effective date of the relevant amendment, the pre-AIA version of § 103 applies.

Petitioner contends that no formal claim constructions are necessary. Pet. 18. Patent Owner does not state a position on claim construction, but does not propose any constructions. *See, generally,* PO Resp.

Based on the complete record, we do not find it necessary to provide express claim constructions for any terms. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (noting that "we need only construe terms 'that are in controversy, and only to the extent necessary to resolve the controversy'") (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

B. Obviousness of Claims 1, 2, and 16–18 over Rosener and Huddart

Petitioner contends that claims 1, 2, and 16–18 would have been obvious over Rosener and Huddart. Pet. 18–56. For the reasons given below, Petitioner has made a sufficient showing as to claims 1, 2, and 16, but not claim 18. We do not reach claim 17 as to this ground, but do address claim 17's patentability in Petitioner's ground asserting Rosener, Huddart, and Vanderelli in Section II.F below.

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are "such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." We resolve the question of obviousness on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

1. Level of Skill in the Art

Dr. Cooperstock testifies that a skilled artisan "would have had at least a Bachelor's Degree in an academic area emphasizing electrical engineering, computer science, or a similar discipline, and at least two years of experience in wireless communications across short distance or local area networks." Ex. 1003 ¶ 34. In the Institution Decision, we found Dr. Cooperstock's testimony to be consistent with the technology described in the Specification and the cited prior art and adopted this level of skill for purposes of that Decision. Dec. 24.

Mr. McAlexander testifies that a skilled artisan "would be someone working in the electrical engineering field and specializing in or knowledgeable of speaker components for small wireless devices," and "would have had a bachelor's degree in electrical engineering and at least two or more years of work experience in the industry. Ex. 2035 ¶ 19. According to Mr. McAlexander, "[s]uch a person would have studied and have practical experience with circuit design, speaker components, and wireless communication." *Id.* Patent Owner states that this proposed level of skill "is not far removed from Petitioner's [person of ordinary skill in the art]." PO Resp. 6.

As Patent Owner acknowledges that the proposed levels of skill are similar, and does not argue that a difference in level of skill would lead to a different result in this proceeding, we continue to adopt Petitioner's proposed level of skill.

2. Scope and Content of the Prior Art

a) Overview of Rosener

Rosener describes wireless systems with "first and second data sinks having no physical or electrical connection therebetween." Ex. 1004, Abstract. The data sinks can be, for example, wireless earphones. *Id.* ¶ 2. Each wireless earphone may be in the form of an earbud designed to fit into the concha of the pinna of the user's ear, and includes a housing containing a speaker, a radio-frequency (RF) transceiver, and a battery. *Id.* ¶ 30.

Each earphone may also include "a clip, earloop, or other suitable securing mechanism to help maintain the earphone . . . on the ear of the user." *Id.* Although Rosener does not have a figure showing a clip or earloop along with a preferred embodiment of the invention, it does depict, in Figure 4 (reproduced below) an earloop used with a prior art Bluetooth-enabled over-the-ear wireless headset:

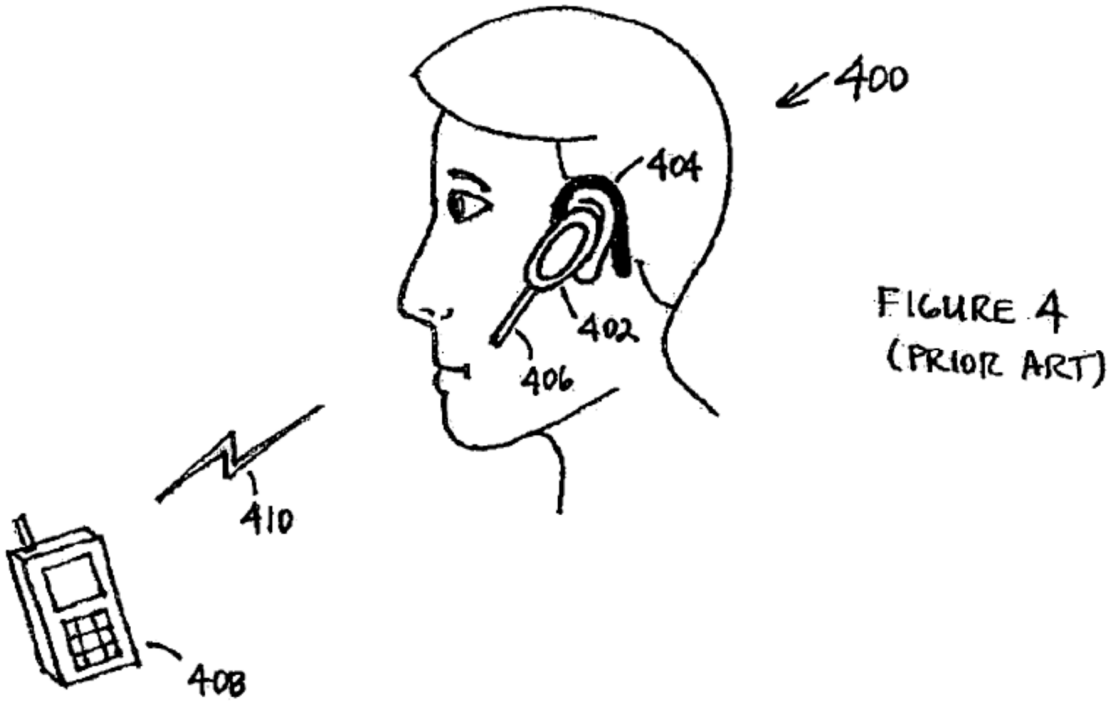

FIGURE 4
(PRIOR ART)

Figure 4 is a drawing of a user wearing a Bluetooth-enabled over-the-ear monaural wireless headset. *Id.* ¶ 17. As shown in Figure 4, headphone 402 includes earloop 404 that is configured to fit around the outer ear of user 400. *Id.* ¶ 8. Figure 5, reproduced below, shows earbuds, but not earloops:

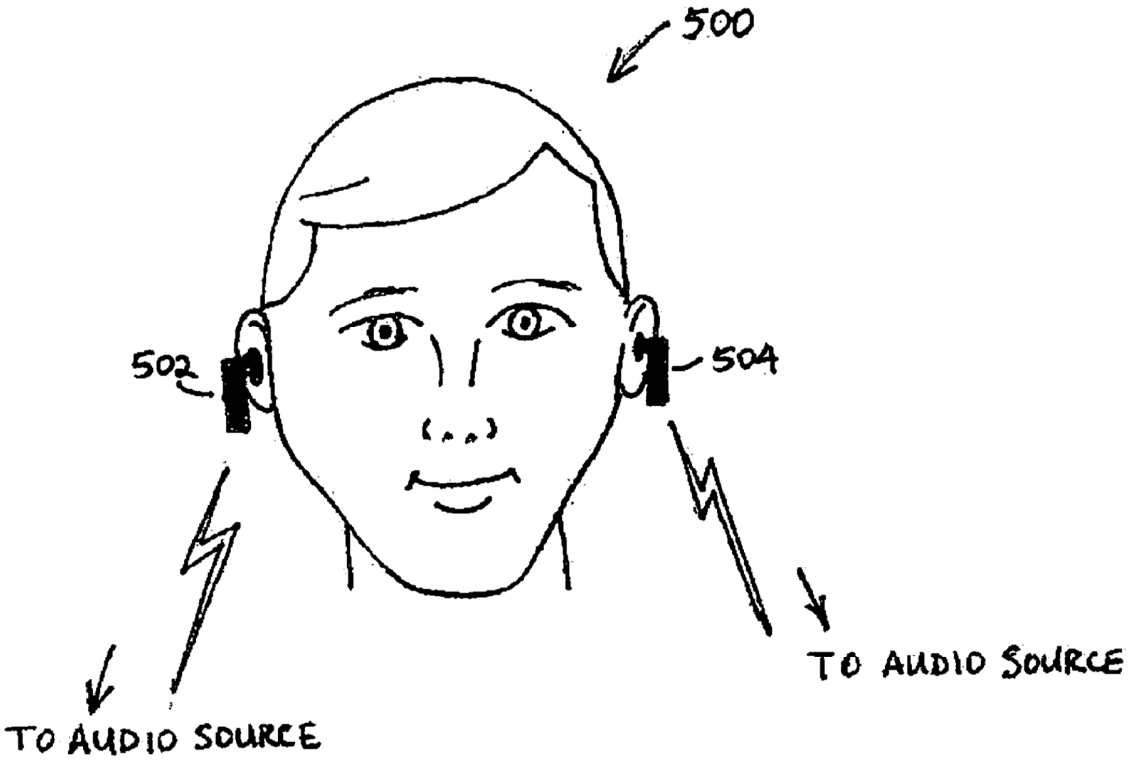

FIGURE 5

Figure 5 is an illustration of the head of a person wearing a headset comprising first and second wireless earphones 502, 504. *Id.* ¶¶ 18, 30.

Figure 9, reproduced below, illustrates some of the components of Rosener's headphones:

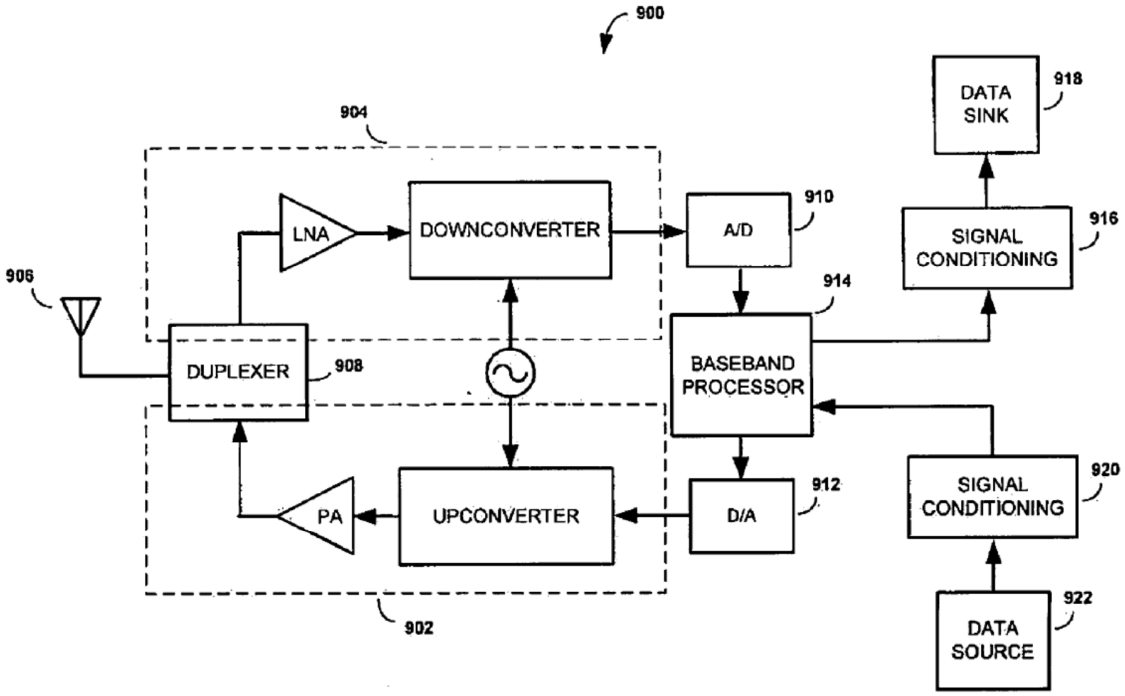

FIGURE 9

Figure 9 is a block diagram of an RF transceiver. *Id.* ¶¶ 24, 49.

RF transceiver 900 includes RF transmitter portion 902, RF receiver portion 904, antenna 906, and duplexer 908. *Id.* ¶ 49. A/D converter 910 receives analog baseband signals from RF transceiver portion 904, digitizes the signals, and sends them to baseband processor 914, which, along with signal conditioning circuit 916, processes the signals into a form suitable to drive data sink (speaker) 918. *Id.* According to Rosener, signal conditioning circuit 916 provides "digital-to-analog conversion, filtering, amplification, and/or other signal processing functions, to ensure that the processed data is in a form suitable to drive the data sink 918." *Id.* Baseband processor 914 receives data from data source 922 (e.g., a microphone) via signal conditioning circuit 920 and provides the data to RF transmitter portion 902 for transmission via antenna 906. *Id.* ¶ 50.

b) Overview of Huddart

Huddart describes wireless stereo headsets. Ex. 1005, Abstract. Figure 1, reproduced below, illustrates an example:

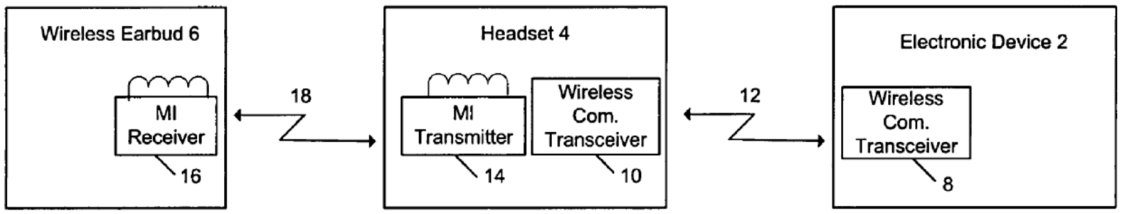

FIG. 1

Figure 1 is a system-view block diagram of a wireless stereo headset system. *Id.* at 1:44–45. Headset 4 is in proximity to electronic device 2 (e.g., a cellular telephone or digital music player), which transmits voice or text data to headset 4. *Id.* at 2:52–3:2. Headset 4 includes a speaker for one ear. "When stereo listening operation is desired by a user, a wireless earbud 6 is used in conjunction with headset 4. Both headset 4 and wireless earbud 6 have wireless communication functionality to form a wireless communication link 18." *Id.* at 3:7–10. "In one example of the invention, a magnetic induction wireless communication link is established between headset 4 and wireless earbud 6. Magnetic induction provides short range wireless communication at low power and cost while providing good audio signal quality." *Id.* at 3:19–23. "In further examples of the invention, other methods of wireless communication may be used to establish wireless communication link 18 between headset 4 and wireless earbud 6. For

example, wireless earbud 6 may be Bluetooth enabled to communicate with either headset 4 or electronic device 2." *Id.* at 3:55–60.

Wireless headset 4 "includes a power source such as a rechargeable battery installed within the housing to provide power to the various components of the receiver." *Id.* at 5:10–12. Similarly, "[w]ireless earbud 6 also includes a power source such as a rechargeable battery and a controller comprising a processor, memory and software to implement functionality as described herein." *Id.* at 5:26–29.

Huddart describes several options for charging the rechargeable batteries of wireless headset 4 and wireless earbud 6, including:

> a charger/carrier, such as a pocket charger, including a small plastic storage case for storing the headset 4 and wireless earbud 6 for protection and charging. The pocket charger includes a battery and charger circuit for charging both the headset battery and wireless earbud battery when inserted into the pocket charger/carrier.

Id. at 8:25–31;

> a charging coil to provide charging current to the wireless earbud battery 84 via receive aerial 52 shown in FIG. 4. The earbud advantageously does not require charging contacts on its small exterior surface when charging is performed with inductive charging. In this example, the single receive aerial 52 functions multiply to receive charging power for battery 84, generate a wake up signal 82, or receive an audio signal carrier.

Id. at 8:35–42; and

> a primary charger to which the pocket charger may be removably attached. The primary charger may be a cable or docking facility connecting the pocket charger/carrier to a wall outlet or primary batter[y] such as a car battery, allowing the headset battery, wireless earbud battery, and the storage case battery to be charged using the wall outlet or primary battery.

Id. at 8:51–57.

3. Differences, if any, Between Claim 1 and the Prior Art; Reasons to Modify or Combine

In essence, Petitioner contends that Rosener teaches the aspects of claim 1 regarding the components of the "pair of first and second wireless earphones," including a power source (although not necessarily a rechargeable power source), and that Huddart teaches the "rechargeable power source" and "docking station" aspects. Pet. 26–30. Patent Owner contests whether Rosener teaches "a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user," as recited in claim 1. PO Resp. 11–20. However, Patent Owner does not challenge any of Petitioner's other allegations for claim 1. We first address the contested "hanger bar" limitation of claim 1 and then address the uncontested limitations.

a) Contested "hanger bar" limitation of claim 1

As to "a body portion," as recited in claim 1, Petitioner cites to the "housing" of Rosener's earphones 502, 404. Pet. 32 (citing Ex. 1004 ¶ 30). We find that the housing of earphones 502, 504 is "a body portion." The parties dispute whether Rosener teaches "a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user," as recited in claim 1.

Petitioner (Pet. 34–35) points to Rosener's description that "[e]ach of the first and second earphone 502, 504 may further include a clip, earloop, or other suitable securing mechanism to help maintain the earphone 502 or 504 on the ear of the user." Ex. 1004 ¶ 30. According to Petitioner, a

skilled artisan would have understood from this description that each of earphones 502, 504 is connected to an earloop, which is an example of a curved hanger bar. Pet. 35.[4]

Petitioner (Pet. 35–36) argues that this description should be read in the context of Rosener's description of the prior art Bluetooth-enabled over-the-ear wireless headset depicted in Figure 4 (reproduced above), that "[t]he headset includes a headphone 402 and an earloop 404 that is configured to fit around the outer ear of the user 400." Ex. 1004 ¶ 8. *See also* Ex. 1003 ¶ 82 ("Though not shown in Figure 5, a [person of ordinary skill in the art] would have understood through this textual description that Rosener's disclosure contemplates some embodiments in which the housing of each of earphones 502, 504 is connected to, for example, an earloop ('curved hanger bar') to improve the manner in which each of the earphones is secured to the user's ear, as taught in Rosener."). Petitioner included in the Petition the following annotated version of Figure 5 (reproduced below) illustrating what earloops on Rosener's earphones might look like:

[4] In the Institution Decision, we considered competing arguments regarding whether an "earloop" as discussed in Rosener is, in fact, a curved hanger bar or whether, instead, it is more akin to the elastic straps that might hold a face mask in place. Dec. 33–34. We found, on the preliminary record, that Rosener's earloop is a curved hanger bar. *Id.* Patent Owner does not argue in its Response that the earloop is not a curved hanger bar and we maintain that finding that it is a curved hanger bar on the complete record for the reasons given in the Institution Decision. *See* Paper 15, 8 ("Patent Owner is cautioned that any arguments not raised in the response may be deemed waived.").

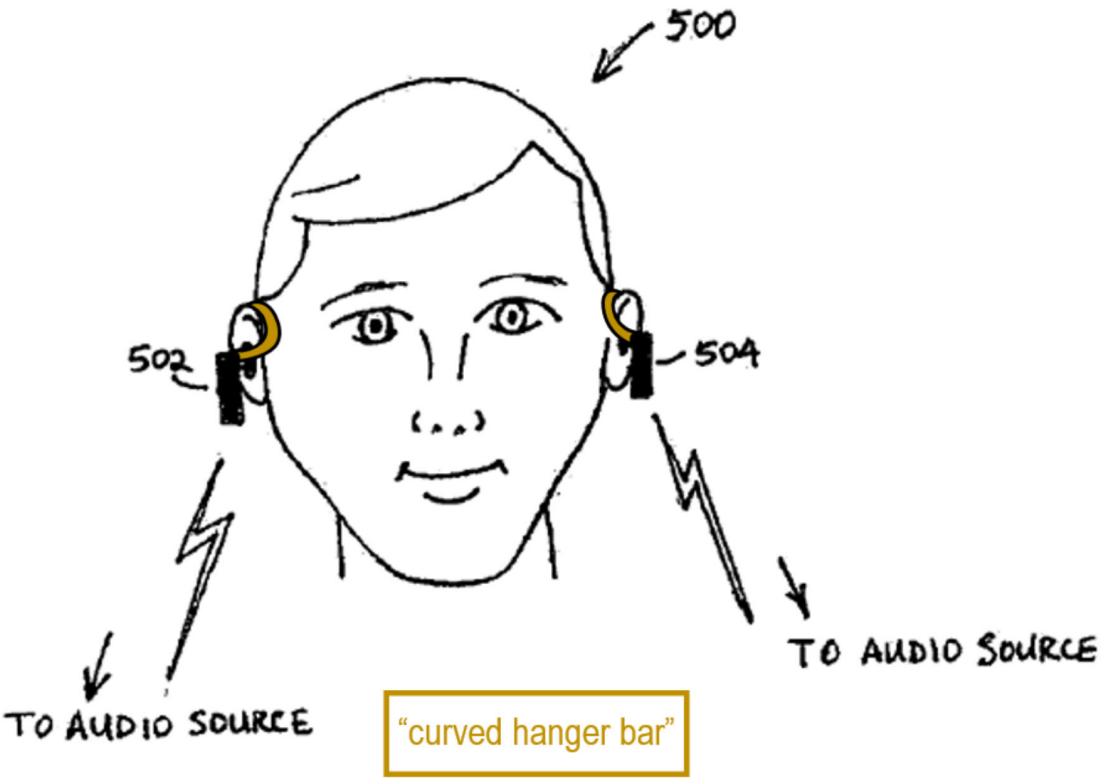

FIGURE 5

The figure above is a version of Rosener's Figure 5, annotated by Petitioner to add gold curved hanger bars to earphones 502, 504. Pet. 36. According to Petitioner, Rosener "thus teaches a system in which each of the elongated portions of the housings of earphones 502, 504 are connected to an earloop providing the same type of securing mechanism as shown for earloop 402," and "discloses this configuration given its teaching that each of earphones 502, 504 can include earloops and acknowledgement that use of earloops was conventional." *Id.* at 37 (citing Ex. 1004 ¶¶ 8, 30; Ex. 1003 ¶ 85).

Patent Owner characterizes Petitioner's position as asserting that "the earloop of Rosener's Figure 4 could be added to the wireless earphones of Rosener's Figure 5," that Petitioner's position relies on its modified version

of Figure 5, and that what Petitioner is arguing is that a skilled artisan would have combined two different embodiments of Rosener, one with the earbud and downwardly extending member of Figure 5 and another with the earloop of Figure 4. PO Resp. 14–15. Characterizing Petitioner's arguments in this way, Patent Owner then argues that a skilled artisan "would not have been motivated to add earloops to the earbud-downwardly extending member combination shown in Figure 5." *Id.* at 5.

Relying on the testimony of Mr. Blair, Patent Owner argues that, if one were to add the earloop of Figure 4 to the earbud and downwardly extending member of Figure 5, the earloop would effectively pry the earbuds out of the listener's ears. PO Resp. 16–18. According to Mr. Blair, the downwardly extending member of the earbud of Figure 5 exerts a downward force that holds the earbud in the ear, while the earloop of Figure 4 exerts a force upward and backward, counteracting the downward force and displacing the earbud from the ear. Ex. 2036 ¶¶ 14–17.[5]

Petitioner replies that Mr. Blair's testimony is conclusory and uncorroborated. Reply 10. Petitioner then argues that Patent Owner mischaracterizes what is shown in its annotated Figure 5 and contends that Mr. Blair's analysis of the various forces exerted on the earbuds is faulty. *Id.* at 10–15. In support, Petitioner offers testimony from Dr. Cooperstock, although that testimony is also conclusory and does not identify the basis for the testimony. Ex. 1023 ¶¶ 11–23.

[5] Mr. McAlexander provides testimony that largely copies the arguments in Patent Owner's Response. Ex. 2035 ¶¶ 37–43. His testimony, however, does not appear to be based upon his own knowledge or expertise and, instead, is based upon his reading of Mr. Blair's testimony. We accord this testimony by Mr. McAlexander little weight.

We need not evaluate which of the experts' views on the various forces on a Figure 4/5 combination would have been correct. Patent Owner improperly limits Petitioner's arguments (and Rosener's disclosure) to a combination of separate embodiments shown alternately in Figures 4 and 5. We agree with Petitioner (Pet. 34–35; Reply 18) and find that Rosener expressly describes earbuds with curved hanger bars. Specifically, Rosener states that "[e]ach of the first and second earphones 502, 504 may be in the form of an earbud designed to fit into the concha of the pinna of the user's ear," and that "[e]ach of the first and second earphone 502, 504 may further include a clip, earloop, or other suitable securing mechanism to help maintain the earphone 502 or 504 on the ear of the user." Ex. 1004 ¶ 30. We read Petitioner's annotated Figure 5 (shown above) as an illustration of how these expressly described features might look together, as Rosener does not have a figure depicting that embodiment. Petitioner relies on Figure 4 to show that "earloops" in fact correspond to "curved hanger bars," not to show precise structure that would be bodily incorporated into the embodiment depicted in Figure 5. We do not read Petitioner's annotated Figure 5 as a proposed physical combination of different embodiments within Rosener. Patent Owner's characterization of Petitioner's combination is not the correct lens through which we analyze obviousness. *See In re Keller*, 642 F.2d 413, 425 (Fed. Cir. 1981) ("To justify combining reference teachings in support of a rejection it is not necessary that a device shown in one reference can be physically inserted into the device shown in the other.").

Patent Owner argues that "Rosener . . . never states which listed earphone forms (e.g., earbud, canalphone, or over-the-ear) could also include an earloop." PO Resp. 19–20. In the Sur-reply, Patent Owner argues that Rosener "describes three separate earphone form factors (i.e.,

earbud, canalphone and over-the-ear circum-aural), but only links one of them—over-the-ear circum-aural—with an earloop. Rosener describes that the first two types—earbuds and canalphones—fit 'into' or 'within' the user's ear." Sur-reply 9–10.

We disagree. Rosener states that earphones 502, 504 could be earbuds and further states that they could include a clip or earloop to help maintain them on the ear of the user. Ex. 1004 ¶ 30. Although other options would be within the scope of this disclosure (e.g., an over-the-ear earphone with an earloop), we see no description in Rosener that would limit Rosener's clip or earloop to only some earphone form factors, and specifically find that Rosener's description of an earloop helping maintain the earphone "on the ear of the user," Ex. 1004 ¶ 30, is not an attempt to exclude earbuds. In sum, we find that Rosener expressly teaches "a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user," as recited in claim 1.

b) Uncontested limitations of claim 1

Regarding "a pair of first and second wireless earphones to be worn simultaneously by a user, wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected," as recited in claim 1, Petitioner (Pet. 30–32) cites to Rosener's earphones 502, 504, which "may be in the form of an earbud designed to fit into the concha of the pinna of the user's ear" and are "physically and electrically-separated" with "no physical or electrical connection" between them. Ex. 1004 ¶¶ 11, 30, Fig. 5. Based

on this evidence, we find that Rosener's earphones 502, 504 teach this limitation.

As to an "earbud extending from the body portion that is inserted into an ear of the user when worn by the user," Petitioner points to earphones 502, 504, shown in Figure 5 as extending from a portion inserted into a user's ear. Pet. 33–34. As Petitioner notes (Pet. 33), Rosener describes earphones 502, 504 as "in the form of an earbud designed to fit into the concha of the pinna of the user's ear." Ex. 1004 ¶ 30. We find that Rosener teaches this limitation as well.

Petitioner contends that Rosener's RF transmitter portion 902, RF receiver portion 904, duplexer 908, A/D converter 910, and D/A converter 912, together constitute "a wireless communication circuit for receiving and transmitting wireless signals." Pet. 37–39 (citing Ex. 1004 ¶¶ 11, 30–36, 49, Figs. 5, 9). We agree. For example, Rosener teaches "[w]ireless systems having a plurality of physically and electrically-separated data sinks . . . . An exemplary wireless system includes first and second data sinks having no physical or electrical connection therebetween." Ex. 1004 ¶ 11.

Petitioner further contends that Rosener's baseband processor 914, signal conditioning circuits 916, 920, and other described circuitry constitute "a processor circuit connected to the wireless communication circuit," as recited in claim 1. *Id.* at 39–41 (citing Ex. 1004 ¶¶ 39–43, 49, 50, Fig. 9). We agree. As noted above, baseband processor 914 receives digitized baseband signals and signal conditioning circuit 916 provides digital-to-analog conversion, filtering, amplification, and other processing. Ex. 1004 ¶ 49.

Petitioner identifies Rosener's "data sink 918" as an "acoustic transducer," as recited in claim 1; Rosener's "data source 922" as "a

microphone for picking up utterances of a user of the headphones"; and Rosener's "antenna 906" as "an antenna connected to the wireless communication circuit." *Id.* at 41–44 (citing Ex. 1004 ¶¶ 2, 30 ("The speaker may comprise, for example, a magnetic element attached to a voice-coil-actuated diaphragm, an electrostatically charged diaphragm, a balanced armature driver, or a combination of one or more of these transducer elements."), 50 ("For the RF transmitter portion 902, a D/A converter 912 is adapted to receive data signals from a data source 922 and operable to convert the data signals into analogs signals, which are upconverted to RF by the RF transmitter in preparation of being radiated over the appropriate wireless link by the antenna 906."), 56 ("a microphone to allow . . . data to be sent back to an external electronic device"), Fig. 9). We find that Rosener teaches each of these limitations.

As to "a rechargeable power source," as recited in claim 1, Petitioner argues that Rosener describes a battery, but concedes that "Rosener does not explicitly describe the batteries being rechargeable." Pet. 44–45 (citing Ex. 1004 ¶ 30). Petitioner contends that Huddart teaches a rechargeable battery. *Id.* at 45 (citing Ex. 1005, 5:26–30). According to Petitioner, "[t]o the extent that Rosener is deemed to not disclose rechargeable batteries, [a person of ordinary skill in the art] would have found it obvious to incorporate a rechargeable battery (e.g., earbud battery) as taught in Huddart into each of Rosener's earphones 502, 504 for providing power to earphone components." *Id.* Citing Dr. Cooperstock's testimony, Petitioner argues that a skilled artisan "would have understood . . . that Rosener's earphones could have incorporated rechargeable batteries since this configuration was conventional around the time of its disclosure, as demonstrated by Huddart." *Id.* at 27 (citing Ex. 1003 ¶ 48). Petitioner contends that rechargeable

batteries would have improved Rosener's earphones "by eliminating or reducing the need to periodically replace the batteries, thereby removing or reducing the cost of doing so and also improving user convenience." *Id.* (citing Ex. 1003 ¶ 49). Dr. Cooperstock further testifies that Rosener's earphones would have benefited from rechargeable batteries in the same manner as Huddart's earbuds, e.g., in that the user could avoid frequent battery replacements. Ex. 1003 ¶ 50. We credit Dr. Cooperstock's testimony and find that a skilled artisan would have had reasons to (e.g., cost, convenience, avoid the need to replace batteries) to incorporate Huddart's teaching of rechargeable batteries into Rosener's earphones, and would have had a reasonable expectation of success in doing so.

Petitioner also cites Huddart for "a docking station for holding at least the first wireless earphone," as recited in claim 1. Pet. 46. Specifically, Petitioner contends that Huddart's charger/carrier and primary charger are examples of a docking station. *Id.* (citing Ex. 1005, 8:25–34). Petitioner contends that Huddart's primary charger can be a cable or docking station facility that allows the charger/carrier to connect to a wall outlet or primary battery, and, thus, teaches "a power cable for connecting to an external device to power the docking station," as recited in claim 1. *Id.* at 46–47 (citing Ex. 1005, 8:51–57). Petitioner argues that Huddart's charger/carrier and primary charger are "for charging at least the first wireless earphone when the first wireless earphone is placed in the docking station," as recited in claim 1. *Id.* at 47 (citing Ex. 1005, 5:9–12, 5:26–30, 8:25–50). Huddart's charger/carrier is described as "a convenient mechanism by which the earbud 6, having a relatively smaller capacity battery due to its limited size, may be recharged in the absence of a primary charger." Ex. 1005, 8:31–34.

Relying on Dr. Cooperstock's testimony, Petitioner argues that Huddart's docking station would have "improve[d] battery capacity when a primary charger is unavailable or to avoid the inconvenience of having to frequently plug the charger into a wall outlet, for instance when traveling." *Id.* at 28 (citing Ex. 1003 ¶ 51). Petitioner also argues that Huddart's charger/carrier would have provided a storage case to prevent Rosener's earphones from being misplaced. *Id.* at 28–29 (citing Ex. 1003 ¶52).

We credit Dr. Cooperstock's testimony and find that Petitioner's proffered reasons to combine Rosener and Huddart have rational underpinning; that a skilled artisan would have combined Huddart's teachings of a docking station with Rosener's earbuds (with rechargeable batteries that would be recharged via the docking station); and that a skilled artisan would have had a reasonable expectation of success in combining these teachings.

Thus, Rosner and Huddart teach each limitation of claim 1.

4. Differences, if any, Between Claims 2 and 16 and the Prior Art; Reasons to Modify or Combine

Petitioner contends that claims 2 and 16 would have been obvious over Rosener and Huddart. Patent Owner does not contest the additional allegations for claims 2 and 16.

Claim 2 depends from claim 1 and adds:

the wireless communication circuits are for receiving, wirelessly, streaming audio content;

the at least one acoustic transducers are for playing the streaming audio content; and

> each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

Petitioner identifies Rosener's RF transmitter portion 902, RF receiver portion 904, duplexer 908, A/D converter 910, and D/A converter 912, collectively, as "wireless communication circuits . . . for receiving, wirelessly, streaming audio content." Pet. 47–49 (citing Ex. 1004 ¶¶ 30, 34, 36, 39–42, 49). Petitioner further identifies Rosener's speaker as "at least one acoustic transducer." *Id.* at 49 (citing Ex. 1004 ¶¶ 30 ("The speaker may comprise, for example, a magnetic element attached to a voice-coil-actuated diaphragm, an electrostatically charged diaphragm, a balanced armature driver, or a combination of one or more of these transducer elements."), 38). As to "a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer," Petitioner cites to Rosener's description of "data buffers in each of the first and second RF receivers 604, 608." *Id.* at 49–50 (citing Ex. 1004 ¶ 39). Based on the evidence presented in the Petition, we find that Rosener teaches each additional limitation of claim 2.

Claim 16 depends from claim 1 and adds "wherein the rechargeable power source comprises wirelessly chargeable circuit components." We agree with Petitioner (Pet. 50–51) and find that Huddart teaches this limitation through its description of inductive charging and that a skilled artisan would had reasons to combine Huddart's teaching of inductive charging with the teachings of Rosener, with a reasonable expectation of success. Ex. 1005, 8:35–50; Ex. 1003 ¶ 103.

5. Claim 17

Claim 17 recites "wherein the rechargeable power source comprises a passive, wireless rechargeable power source." Petitioner argues that "the claim language is not clear as to how a *passive* wireless rechargeable power source differs from other wireless rechargeable power sources." Pet. 51. Petitioner argues that claim 17 would have been obvious over Rosener, Huddart, and Vanderelli if claim 17 is construed in light of the Specification. Pet. 51. We address these allegations in Section II.F below. In the alternative, Petitioner argues that, if we adopt a broader construction of claim 17 that is "divorced from the '325 patent specification," we should find it taught by Rosener and Huddart. *Id.* at 51–52. Because we find that the combination of Rosener, Huddart, and Vanderelli teaches the additional limitation of claim 17, as explained below, we do not reach whether Rosener and Huddart teach this limitation under a broader construction. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner "is entitled to a final written decision addressing all of the claims it has challenged"); *Bos. Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App'x 984, 990 (Fed. Cir. 2020) (non-precedential) (recognizing that the "Board need not address issues that are not necessary to the resolution of the proceeding" and, thus, agreeing that the Board has "discretion to decline to decide additional instituted grounds once the petitioner has prevailed on all its challenged claims").

6. Differences, if any, Between Claim 18 and the Prior Art; Reasons to Modify or Combine

As to claim 18, for "wherein the processor circuit of each of the first and second earphones comprises: . . . a baseband processor circuit that is in

communication with the wireless communication circuit of the earphone," Petitioner cites to a description of Rosener's baseband processor 914 and associated circuitry. *Id.* at 55–56 (citing Ex. 1004 ¶¶ 30, 49, Fig. 9). We agree that baseband processor 914 is a baseband processor circuit, and Figure 9 depicts baseband processor 914 in communication with RF transmitter portion 902, RF receiver portion 904, duplexer 908, A/D converter 910, and D/A converter 912, the alleged "wireless communication circuit of the earphone." Patent Owner does not contest Petitioner's allegations for this limitation of claim 18.

The parties dispute whether Rosener and Huddart teach "wherein the processor circuit of each of the first and second earphones comprises: a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone," as recited in claim 18.

Petitioner cites to description of Rosener's signal conditioning circuit 916 and identifies that component as corresponding to the claimed digital signal processor (DSP). *Id.* at 53–55 (citing Ex. 1004 ¶¶ 30, 34, 36, 38, 49, Fig. 9). In particular, Petitioner points to Rosener's description that signal conditioning circuit 916 provides "digital-to-analog conversion, filtering, amplification, and/or other signal processing functions, to ensure that the processed data is in form suitable to drive the data sink 918." *Id.* at 54 (quoting Ex. 1004 ¶ 49). Dr. Cooperstock testifies that signal conditioning circuit 916 "would have conditioned the signal to, for example, reduce or eliminate the effects of noise on the signal through filtering, which enhances sound quality." Ex. 1003 ¶ 111.

Patent Owner argues that Rosener's signal conditioning circuit 916 is a digital-to-analog converter (DAC), rather than a DSP, as its purpose is to

drive the headphone's speaker (data sink 918). PO Resp. 22–24 (citing Ex. 1004 ¶¶ 30 49; Ex. 2035 ¶ 50). Patent Owner, relying on Mr. McAlexander's testimony, contends that a DSP "is a circuit that performs mathematical functions on digital signals (like digital audio signals when used with speakers and earphones)." *Id.* at 24 (citing Ex. 2035 ¶ 53). Patent Owner further argues that a DSP is a processor and, as such, "typically includes the building blocks of a processor, such as an Arithmetic Logic Unit, shift registers, and memory space." *Id.* (citing Ex. 2035 ¶ 54).

Petitioner does not appear to contest Patent Owner's arguments that a DSP must be a processor, with components like arithmetic logic units, shift registers, and memory space, that performs mathematical functions on digital signals. Reply 19–22.[6] Indeed, Petitioner provides no proposed construction in either the Petition or the Reply, and contends instead that DSP "should be interpreted based on . . . its plain meaning." Reply 21. Rather, Petitioner argues that signal conditioning circuit 916 is more than a DAC, and performs filtering, amplification, and other signal processing

[6] Petitioner does argue that Patent Owner is incorrect to suggest that a DSP must be embodied as a single chip or integrated circuit. Reply 21–22. We do not read Patent Owner's arguments to limit a DSP to a single chip. PO Resp. 25 (arguing that "[a] DSP is often embodiment as a single chip (i.e., integrated circuit)"). In any case, we see no persuasive evidence that would limit a DSP to a single chip or integrated circuit.

functions. *Id.* at 19–20 (citing Ex. 1004 ¶ 49).[7] Petitioner equates the filtering, amplification, and other signal processing performed by signal conditioning circuit 916 to the "noise cancelation and sound equalization" listed by the '325 patent as examples of "various sound quality enhancements" performed by DSP 114. Reply 22–23; Ex. 1001, 7:34–37.

Patent Owner responds that

> [m]erely because Rosener's signal conditioning circuit can perform amplification and filtering does not mean that the amplification and filtering are of ***digital*** signals. Thus, the amplification and filtering by Rosener's "signal conditioning circuit" do not even necessarily involve processing of digital signals. Also, neither Rosener nor Cooperstock explained why it would have been obvious that the amplification and filtering performed by Rosener's signal conditioning circuit would have been digital.

Sur-reply 12–13. Patent Owner's concern is well-founded. Dr. Cooperstock admits that filtering and amplification are techniques for processing analog as well as digital signals. Ex. 2040, 9:10–10:8. Rosener describes signal conditioning circuit 916 as receiving data (presumably in digital format) from baseband processor 914, performing processing including digital-to-

[7] Petitioner also argues, for the first time in the Reply, that "'digital-to-analog conversion' is an example of a 'signal processing function.'" Reply 20–21. If Petitioner is attempting to argue that a DAC is a DSP, Petitioner did not make such an argument in the Petition and we do not entertain it here. *See* Patent Trial and Appeal Board Consolidated Trial Practice Guide (Nov. 2019) ("TPG"), 73–74 ("While replies and sur-replies can help crystalize issues for decision, a reply or sur-reply that raises a new issue or belatedly presents evidence may not be considered."), *available at* https://www.uspto.gov/TrialPracticeGuideConsolidated. Nevertheless, Petitioner does not articulate that argument clearly or support it with persuasive evidence. Thus, the argument would not be persuasive even if considered.

analog conversion, filtering, and amplification, and producing an output suitable to drive data sink 918. Ex. 1004 ¶ 49. The most logical reading of this description is that signal conditioning circuit 916 receives a digital signal, converts it to an analog signal, and filters and amplifies that signal to condition it to appropriately drive a speaker. In other words, consistent with Mr. McAlexander's testimony, the filtering and amplification are part of the digital-to-analog conversion process that converts and conditions a signal to drive a speaker. Ex. 2035 ¶¶ 49–52. Petitioner does not expressly argue in the Petition or the Reply that the filtering and amplification are performed on digital signals, or provide persuasive evidence that would support such an argument. Pet. 53–55; Reply 19–23; Ex. 1003 ¶¶ 110–111; Ex. 1023 ¶¶ 35–41.

For the first time at the oral argument, Petitioner argues that Rosener's data sink 918 might receive a digital signal instead of an analog signal and, thus, the filtering and amplification performed in signal conditioning circuit 916 could be performed on digital signals. Tr. 22:17–23:13. Petitioner argues that this is taught in paragraph 36 of Rosener. *Id.* Petitioner further argues that Mr. McAlexander admitted on cross-examination that signal conditioning circuit 916 performs filtering in the digital domain. *Id.* at 54:12–57:1 (citing Ex. 1024, 162). Petitioner did not raise these arguments in its Petition or Reply and, therefore, we do not consider them. *See* TPG 85–86; *Dell Inc. v. Acceleron, LLC*, 818 F.3d 1293, 1301 (Fed. Cir. 2016).

Moreover, Petitioner's arguments would not be persuasive even if considered. Paragraph 36 of Rosener describes Rosner's Figure 6, reproduced below:

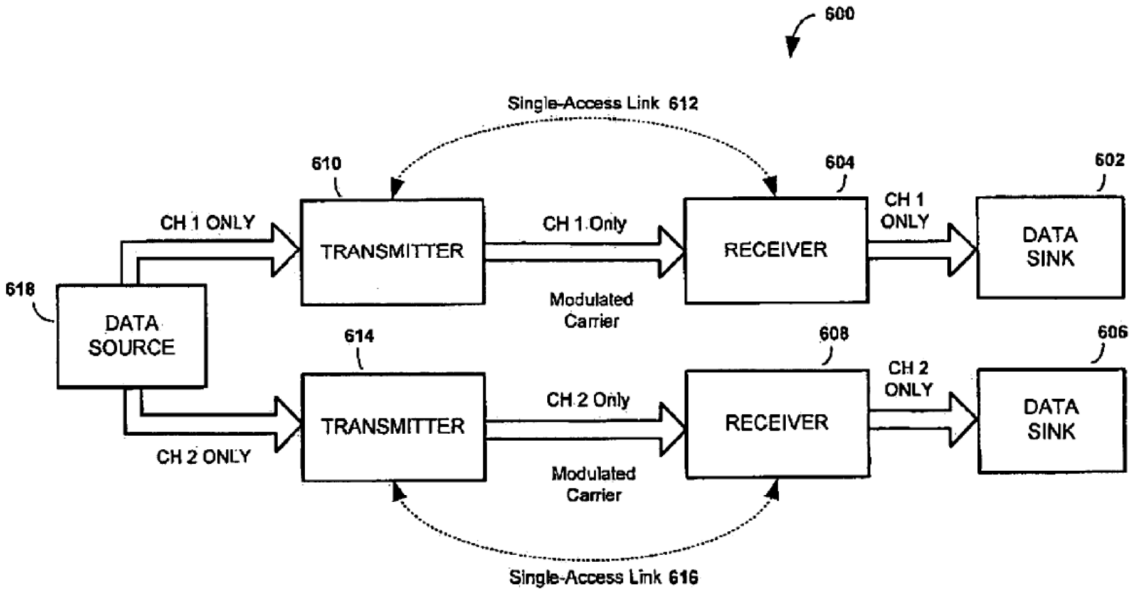

FIGURE 6

Figure 6 is a block diagram of a wireless system used to wirelessly transmit data signals to two or more data sinks. Ex. 1004 ¶19. First and second data streams are modulated onto RF carriers by first and second RF transmitters 601, 614 and transmitted wirelessly to first and second RF receivers 604, 608. *Id.* ¶ 36. RF receivers 604, 608 down-convert the modulated RF carriers and electrically couple the demodulated data streams to first and second data sinks 602, 606. *Id.* According to Rosener, the baseband portions of first and second RF receivers 604, 608 may also contain a DAC and/or other or additional processing circuitry to facilitate the electrical coupling of first and second RF receivers 604, 608 to first and second data sinks 602, 606. *Id.* "Alternatively, such components may be included as part of the data sinks 602, 606 themselves." *Id.*

Petitioner appears to argue that, here, Rosener describes a data sink with a DAC and, by implication, signal conditioning circuit 916 of Figure 9 would operate (filter, amplify) only on digital signals if connected to that

sort of data sink. We are not persuaded. Rosener does not explain how the components of Figure 9 would be used or modified if data sink 918 included a DAC. As noted above, the best reading of Rosener is that signal conditioning circuit 916 converts a digital signal to an analog signal and filters/amplifies that analog signal to put it into condition to drive a speaker. Presumably, if the DAC functionality is moved to data sink 918, the other signal conditioning functionality, such as filtering and amplification, would be moved as well, rendering signal conditioning circuit 916, as depicted, unnecessary (or incorporated into data sink 918). Petitioner offers no persuasive evidence that signal conditioning circuit 916 would perform sound quality enhancing digital signal processing in this scenario.

Mr. McAlexander's cross-examination testimony is not inconsistent with our reading of Rosener. Mr. McAlexander testifies that a signal conditioning circuit would have resistor-capacitor filters both before and after a DAC as part of signal conditioning, not digital signal processing. Ex. 1024, 162:2–164:12. Petitioner does not show persuasively that this would be digital signal processing to provide a sound quality enhancement for the audio content played by the speaker.

In sum, Petitioner has not shown, by a preponderance of the evidence, that the combination of Rosener and Huddart teaches "wherein the processor circuit of each of the first and second earphones comprises: a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone," as recited in claim 18.

Patent Owner raises a second dispute as to this claim limitation. Although it is not necessary to reach this dispute to assess the patentability of claim 18, Patent Owner refers to its claim 18 arguments when responding

to Petitioner's challenge to claims 9 and 10 (discussed in detail below). PO Resp. 34–35. Thus, we discuss Patent Owner's second argument for claim 18.

As noted above for claim 1, Petitioner contends that, "[t]o the extent that Rosener is deemed to not disclose rechargeable batteries, [a person of ordinary skill in the art] would have found it obvious to incorporate a rechargeable battery (e.g., earbud battery) as taught in Huddart into each of Rosener's earphones 502, 504 for providing power to earphone components." Pet. 45. Patent Owner does not contest these allegations for claim 1 and, for the reasons given above, we find that a skilled artisan would have combined the teachings of Rosener and Huddart for the limitation of claim 1, "a rechargeable power source."

Nevertheless, Patent Owner contests this limitation as it pertains to claim 18. Specifically, Patent Owner argues that Huddart does not describe a rechargeable battery that would be capable of powering Rosener's earbud if the earbud were to include a DSP and a baseband processor. PO Resp. 27–32. Patent Owner contends that Huddart describes a "relatively ***smaller capacity battery due to its limited size***." *Id.* at 28 (quoting Ex. 1005, 8:32–33). Patent Owner argues that Huddart's battery is recharged using a small plastic storage case and that "[i]f a larger-capacity battery was needed to power the additional components of the earbud, such as a DSP and baseband processor per claim 18, Huddart's pocket charger would not be suitable for charging the battery of the wireless earbud." *Id.* Patent Owner does not cite to evidence for this contention.

To support its contention that Huddart's battery is "low-power," Petitioner argues that Huddart describes its headset and wireless earbud as communicating using magnetic induction, which Huddart characterizes as

providing short range wireless communication at low power. *Id.* at 29 (citing Ex. 1005, 3:8–14, 3:21–23, 3:43–46). In contrast, Patent Owner argues, a DSP and a baseband processor are high-level integrated circuits that "consume and require a greater amount of battery power than a magnetic inductance receiver." *Id.* at 29–30 (citing Ex. 2035 ¶ 62). According to Patent Owner, "[g]iven the significant power requirements of a DSP and baseband processor, a [person of ordinary skill in the art] would not be motivated to use Huddart's low-power battery, which is designed to merely power a low-power magnetic inductance receiver and the related components of Huddart's earbud." *Id.* at 30. Patent Owner argues that "Huddart's low-power battery [would] be unreliable, undesirable, and/or incompatible for use to power the claimed DSP and baseband processor due to its small capacity." *Id.*

As noted above, communication via magnetic induction is only one example contemplated by Huddart, and Bluetooth communication is another described option. Ex. 1005, 3:19–60. Patent Owner dismisses this alternative, arguing that "Huddart fails to disclose whether a Bluetooth enabled earbud would be compatible with the low power battery discussed solely in connection with the magnetic induction communication system or whether a larger, higher power battery would be needed." PO Resp. 31. However, we see nothing in Huddart to suggest that the battery it describes would be insufficient to power its alternative embodiment.

Patent Owner also argues that the additional power needed for a DSP and baseband processor would increase the drain on Huddart's battery, causing it to generate heat that would be undesirable in an earbud worn on the face. PO Resp. 30–31 (citing Ex. 2035 ¶ 63). Patent Owner further

argues that a battery with a larger capacity than that of Huddart would have been too heavy to be used in a wireless earphone. *Id.* (citing Ex. 2035 ¶ 63).

Petitioner argues that Patent Owner misinterprets Petitioner's mapping of Rosener and Huddart to the claims. Reply 23–24. Specifically, Petitioner argues that Rosener teaches a rechargeable power source and that it "relie[s] on Huddart for its disclosure of an earbud battery being rechargeable and proposed modifying Rosener's battery to be similarly rechargeable." *Id.* at 23. In the Petition, Petitioner argues that

> While Rosener does not explicitly describe the batteries being rechargeable, a [person of ordinary skill in the art] would have understood that earphones 502, 504 could have been configured with rechargeable batteries since the use of such batteries in wireless devices was well-known before the Critical Date as shown, for example, Huddart's disclosure of its "wireless earbud" including a "power source such as a rechargeable battery."

Pet. 44–45. Petitioner continues, "[t]o the extent that Rosener is deemed to not disclose rechargeable batteries, [a person of ordinary skill in the art] would have found it obvious to incorporate a rechargeable battery (e.g., earbud battery) as taught in Huddart into each of Rosener's earphones 502, 504 for providing power to earphone components." *Id.* at 45; *see also id.* at 27 ("A [person of ordinary skill in the art] would have understood, however, that Rosener's earphones could have incorporated rechargeable batteries since this configuration was conventional around the time of its disclosure, as demonstrated by Huddart."). Petitioner further argues that Patent Owner does not contest that Rosener's battery, when modified to be rechargeable, would have been sufficient to power a digital signal processor. *Id.* at 23.

We agree with Petitioner. Petitioner did not contend in the Petition that a skilled artisan would have swapped Huddart's battery for Rosener's.

Indeed, that is not how we typically evaluate obviousness. *See In re Mouttet*, 686 F.3d 1322, 1332–33 (Fed. Cir. 2012) ("It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements. . . . Rather, the test for obviousness is what the combined teachings of the references would have suggested to those having ordinary skill in the art."). Instead, Petitioner argues that a skilled artisan would have made Rosener's battery rechargeable, as that would have eliminated the need to replace batteries and would have been more convenient to users, and that Huddart showed that it was well-known that earbuds could be equipped with rechargeable batteries. Pet. 27. We credit Dr. Cooperstock's testimony in support of these arguments. Ex. 1003 ¶¶ 48–50. Setting aside the issue whether signal conditioning circuit 916 is a DSP (above, we find that it is not), Patent Owner does not contest that Rosener's battery is at least sufficient to power the circuitry specifically described in Rosener, including signal conditioning circuit 916 and baseband processor 914. Tr. 46:17–21. We find that a skilled artisan would have had reasons, with rational underpinning, to use a rechargeable battery with Rosener's earphones (Huddart shows that this was conventional), and that the skilled artisan would have selected a rechargeable battery sufficient to power Rosener's circuitry.

7. Objective Indicia of Nonobviousness

Patent Owner argues that the commercial success of the invention of the challenged claims evidences nonobviousness. PO Resp. 37–42.

"[E]vidence of secondary considerations may often be the most probative and cogent evidence in the record." *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983). For example,

> Commercial success is relevant because the law presumes an idea would successfully have been brought to market sooner, in response to market forces, had the idea been obvious to persons skilled in the art. Thus, the law deems evidence of (1) commercial success, and (2) some causal relation or "nexus" between an invention and commercial success of a product embodying that invention, probative of whether an invention was non-obvious.

Merck & Co. v. Teva Pharms. USA, Inc., 395 F.3d 1364, 1376 (Fed. Cir. 2005). "[T]o be accorded substantial weight in the obviousness analysis, the evidence of secondary considerations must have a 'nexus' to the claims, *i.e.*, there must be 'a legally and factually sufficient connection' between the evidence and the patented invention." *Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019) (quoting *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988)).

"[A] patentee is entitled to a rebuttable presumption of nexus between the asserted evidence of secondary considerations and a patent claim if the patentee shows that the asserted evidence is tied to a specific product and that the product '*is* the invention disclosed and claimed.'" *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (quoting *Demaco*, 851 F.2d at 1392). "That is, presuming nexus is appropriate 'when the patentee shows that the asserted objective evidence is tied to a specific product and that product embodies the claimed features, and is coextensive with them.'" *Id.* (quoting *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1072 (Fed. Cir. 2018) (additional internal quotation marks omitted)). "Conversely, '[w]hen the thing that is commercially successful is not

coextensive with the patented invention—for example, if the patented invention is only a component of a commercially successful machine or process,' the patentee is not entitled to a presumption of nexus." *Id.* (quoting *Demaco*, 851 F.2d at 1392) (alteration by Federal Circuit). "'The patentee bears the burden of showing that a nexus exists.'"[8] *Id.* (quoting *WMS Gaming Inc. v. Int'l Game Tech.*, 184 F.3d 1339, 1359 (Fed. Cir. 1999)).

If we do not presume nexus, "[t]o establish a proper nexus between a claimed invention and the commercial success of a product, a patent owner must offer 'proof that the sales were a direct result of the unique characteristics of the claimed invention—as opposed to other economic and commercial factors unrelated to the quality of the patented subject matter.'" *SightSound Techs., LLC v. Apple Inc.*, 809 F.3d 1307, 1319 (Fed. Cir. 2015) (quoting *In re Huang*, 100 F.3d 135, 140 (Fed. Cir. 1996)); *accord Fox Factory*, 944 F.3d at 1373–74 ("A finding that a presumption of nexus is inappropriate does not end the inquiry into secondary considerations. To the contrary, the patent owner is still afforded an opportunity to prove nexus by showing that the evidence of secondary considerations is the 'direct result of the unique characteristics of the claimed invention.'" (quoting *Huang*, 100 F.3d at 140)).

[8] The parties agree that Patent Owner bears the burden of persuasion on nexus. Reply 31–32; Tr. 51:3–22. In a related hearing conducted on the same day between the same parties, Patent Owner expressly agreed that it bears the burden of persuasion on the issue of nexus. IPR2021-00255, Paper 53 (Mar. 3, 2022, Oral Argument Transcript) at 43:8–23. Patent Owner stated that we can rely on that agreement in this proceeding. Tr. 51:3–22.

Patent Owner argues that the commercial success of the Powerbeats Pro, a product by Petitioner's subsidiary Beats by Dr. Dre, is objective evidence of the nonobviousness of the challenged claims.[9] PO Resp. 37–42. The parties dispute whether Patent Owner has shown a nexus between the commercial success of the Powerbeats Pro and the claimed invention.

Patent Owner argues that "[i]n light of the extreme coextensiveness between the Powerbeats Pro and claims 1–18 of the '325 Patent, the Board should presume a nexus between the commercial success of the Powerbeats Pro and claims 1–18." PO Resp. 41. In support of this argument that the Powerbeats Pro product is coextensive with the claimed invention, Patent Owner cites to its infringement contentions served in the Texas case, and argues that "claims 1–18 of the '325 Patent read on the Powerbeats Pro." *Id.* at 38 (citing Ex. 1014, 1079–113), 40 (same); Sur-reply 19 ("The [Patent Owner Response] cited an exhibit, APPLE-1014, 1079–1113, that includes a detailed claim chart showing that the PowerBeats Pros possess all the elements of the Challenged Claims."). Patent Owner does not provide a detailed comparison of the Powerbeats Pro with the challenged claims in its Response. PO Resp. 37–42. At most, Patent Owner points out certain features of the Powerbeats Pro, such as being "completely wireless" and having a "a signature earhook design." *Id.* at 37–38, 40. However, Patent Owner's attempt to incorporate its infringement contentions by reference into the Response is contrary to our rules, and those infringement

[9] Patent Owner's evidence of commercial success shows success at the level of a category that would include the Powerbeats Pro, but does not break out the Powerbeats Pro individually. PO Resp. 38, 41–42 (citing Exs. 2037, 2038). Nevetheless, Petitioner does not contest that the Powerbeats Pro product has been commercially successful.

contentions will be disregarded. *See* 37 C.F.R. § 42.6(a)(3) ("Arguments must not be incorporated by reference from one document into another document."). Accordingly, Patent Owner has not shown that the Powerbeats Pro practices the invention of the challenged claims and, for that reason, has not shown that the Powerbeats Pro is coextensive with the challenged claims.

Additionally, Petitioner points to features of the Powerbeats Pro, not recited in the challenged claims, that it alleges are responsible for the commercial success of that product. Reply 32–34. "Although we do not require the patentee to prove perfect correspondence to meet the coextensiveness requirement, what we do require is that the patentee demonstrate that the product is essentially the claimed invention." *Fox Factory*, 944 F.3d at 1374. On one hand, "if the unclaimed features amount to nothing more than additional insignificant features, presuming nexus may nevertheless be appropriate." *Id.* On the other, a claim is not coextensive with a product that includes a "critical" unclaimed feature that materially impacts the product's functionality. *Id.* at 1375.

In particular, Petitioner argues that the Powerbeats Pro includes a speech-detecting accelerometer in each earbud, two beam-forming microphones per side to help filter out sounds such as wind and ambient noise, a proprietary chip package that provides a faster and more stable wireless connection, and wireless audio sharing functionality and location tracking using a phone to determine if the headphones are lost or missing. Reply 32–33 (citing Ex. 1028; Ex. 2039, 3–4). Petitioner argues that these unclaimed features materially impact the Powerbeats Pro's functionality and points to product reviews to show that the proprietary chip package improves quality and latency. *Id.* at 33 (citing Exs. 1029, 1030).

Patent Owner responds that much of what Petitioner argues are unclaimed features are, in fact, claimed. Sur-reply 19–20. Specifically, Patent Owner argues that claim 1's recitation of a "microphone" corresponds to the two beam-forming microphones in Powerbeats Pro; the "processor circuit" of claim 1 corresponds to the proprietary chip package of Powerbeats Pro; and that claim 18's recitation of a "digital signal processor that provides a sound quality enhancement" corresponds to the speech-detecting accelerometer and two-beam forming microphones of Powerbeats Pro. *Id.* Patent Owner, however, offers no evidence to support these arguments.[10] *Id.* Patent Owner's attorney argument is not persuasive to meet its burden to show that the challenged claims are coextensive with Powerbeats Pro. In any case, we agree with Petitioner that these particular features of Powerbeats Pro do not appear to be coextensive with the recitations in claims 1 and 18. *Cf. Fox Factory*, 944 F.3d at 1376 ("On a broader note, if we were to agree . . . that the coextensiveness requirement is met so long as the patent claim broadly covers the product that is the subject of the secondary considerations evidence, irrespective of the nature of any

[10] We recognize that, ordinarily, "[t]he sur-reply may not be accompanied by new evidence other than deposition transcripts of the cross-examination of any reply witness." TPG 73. In this instance, it is Patent Owner's burden to prove that the challenged claims are coextensive with the Powerbeats Pro in order to show nexus via coextensiveness. *See Fox Factory*, 944 F.3d at 1373. Thus, Patent Owner should have marshaled evidence of coextensiveness, including evidence as to unclaimed features, with its Response. Paper 15 (Scheduling Order) 8 (Patent Owner is cautioned that any arguments not raised in the response may be deemed waived."); TPG 73–74 ("Sur-replies should only respond to arguments made in reply briefs, comment on reply declaration testimony, or point to cross-examination testimony."). In any case, Patent Owner did not request an opportunity to submit additional evidence with its Sur-reply.

unclaimed features—then the coextensiveness requirement would rest entirely on minor variations in claim drafting."). Moreover, Patent Owner does not contest that other features, such as wireless audio sharing functionality and location tracking using a phone, are features of Powerbeats Pro but not claimed in the challenged claims.

Patent Owner also argues that, even if the features of Powerbeats Pro are not claimed in the challenged claims, those features "are not for improving the 'heart,' or purpose, of the '325 Patent." Sur-Reply 20–21. In a similar argument, Patent Owner contends that "even if any of the Powerbeats Pro's features identified in the Reply could be considered unclaimed, there is no evidence that they are critical or significant to performing the function of the '325 Patent's earphones better." *Id.* at 21. Specifically, Patent Owner argues, "Petitioner . . . did not introduce any evidence to show that the speech-detecting accelerometer, beam-forming microphones, ambient noise filtering, wireless audio sharing and/or location tracking are critical to securing a pair of independently wireless earphones to the user." *Id.* at 21–22. This misstates the law. *Fox Factory* did not hold that unclaimed features must be critical to or for improving the heart of the challenged claims. Rather, we look to whether the unclaimed features "materially impact[] the product's functionality." *Fox Factory*, 944 F.3d at 1375. Thus, when *Fox Factory* states that "if the unclaimed features amount to nothing more than additional insignificant features, presuming nexus may nevertheless be appropriate," *id.* at 1374, it means insignificant to the product, not insignificant to the challenged claims. Patent Owner does not argue, and has not presented evidence, that the unclaimed features of Powerbeats Pro are insignificant to, or do not materially impact, the Powerbeats Pro product and its success.

For these reasons, even if we consider Patent Owner's improperly incorporated claim charts, we still conclude that Patent Owner has not met its burden to prove that the challenged claims and Powerbeats Pro are coextensive. Thus, Patent Owner has not shown a nexus between the commercial success of Powerbeats Pro and the invention of the challenged claims by virtue of coextensiveness.

As noted above, Patent Owner may still show nexus by showing that the commercial success of the Powerbeats Pro is the direct result of the unique characteristics of the claimed invention. *See Fox Factory*, 944 F.3d at 1373–74; *Huang*, 100 F.3d at 140. To that end, Patent Owner argues in the Response that "[a]t a minimum, a nexus between the Powerbeats Pro [and] the Challenged Claims exists because the commercial success is the direct result of the unique characteristics of the claimed invention." PO Resp. 41. Patent Owner does not cite to evidence to support this statement, and does not identify, in the Response which "unique characteristics" it relies on. *Id.*

In its arguments regarding coextensiveness, Patent Owner identified the "completely wireless" nature and "signature earhook design" of the Powerbeats Pro. *Id.* at 37–38, 40. In the Sur-reply, Patent Owner attempts to tie these two features to "unique characteristics" of the challenged claims. Sur-reply 23 ("The [Patent Owner Response] explained how Petitioner's press releases touted the 'completely wireless' nature of the headphones as well as the 'signature earhook design' of the PowerBeats Pros.") (citing PO Resp. 37–38; Ex. 2039, 1). Patent Owner has not shown persuasive evidence to support an argument that the commercial success of the Powerbeats Pro was the direct result of these features. The press release of Exhibit 2039 characterizes the Powerbeats Pro as

> completely wireless earphones that deliver powerful sound for the world's most passionate music lovers and motivated athletes. The result of a deep integration between Beats and Apple engineering, Powerbeats Pro features industry-leading battery life, advanced functionality, reliable connectivity, exceptional fit via the signature earhook design and beautiful fidelity.

Ex. 2039, 2. This press release purportedly published on April 3, 2019, (Ex. 2039, 2), while Patent Owner relies on commercial success that took place after this date, in "Q3 2019" (PO Resp. 41). Patent Owner does not explain persuasively why a press release published before the period of alleged commercial success is evidence of the reasons for that success.

In sum, we conclude that Patent Owner has not shown a nexus between the challenged claims and the alleged commercial success of the Powerbeats Pro. Accordingly, Patent Owner's objective indicia of nonobviousness is particularly weak and unpersuasive.

8. Conclusion of Obviousness

As explained above, the combination of Rosener and Huddart teaches each limitation of claims 1, 2, and 16, but not claim 18. Petitioner has introduced persuasive evidence that a skilled artisan would have had reasons to combine the teachings of Rosener and Huddart with a reasonable expectation of success. We have considered Patent Owner's arguments and evidence of objective indicia of nonobviousness, but do not find it persuasive, for the reasons explained above. In sum, upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claims 1, 2, and 16 would have been obvious over Rosener and Huddart. Petitioner has not proved, by a preponderance of the evidence, that claim 18 would have been obvious over Rosener and Huddart.

C. Obviousness of Claims 3 and 4 over Rosener, Huddart, and Haupt

Petitioner contends that claims 3 and 4 would have been obvious over Rosener, Huddart, and Haupt. Pet. 57–64. Patent Owner does not challenge Petitioner's additional allegations for claims 3 and 4.

Haupt describes techniques for downloading digital data (e.g., MP3 music files) from the Internet using a computer (e.g., a PDA or notebook computer wirelessly connected to a network) and distributing those digital data to wireless headphones. Ex. 1006, 1.

Claim 3 depends from claim 1 and adds "wherein the processor circuit for the first earphone is for, upon activation of a user control of the headphones, initiating transmission of a request to a remote network server that is remote from the headphones." Claim 4 depends from claim 3 and adds "wherein the processor circuit of the first earphone is further for receiving a response to the request."

As we find above, Rosner teaches a processor circuit, for example broadband processor 914, signal conditioning circuits 916, 920, and other processing circuitry. Ex. 1003 ¶ 114. Petitioner contends that Haupt teaches activation of a user control of headphones and corresponding transmission of a request to a remote network server, after which the server sends, and the headphones receive, a response (e.g., downloaded audio content). Pet. 61–64. In particular, Petitioner cites to Haupt's description of interacting with control buttons on wireless headphones to connect with a server and retrieve audio files over a network. *Id.* (citing Ex. 1006, 2–5, 10–14, 21). Petitioner, relying on Dr. Cooperstock's testimony, contends that a skilled artisan would have combined Haupt's teachings with those of Rosener and Huddart to "improve[] performance when streaming data streams with high throughput requirements due to the increased data transmission rates,"

"impart[] new and useful functionality to [Rosener's] earphones 502, 504 as audio playback devices," and "provid[e] Internet access to the headphones." *Id.* at 58–61 (citing Ex. 1003 ¶¶ 57–61). We credit Dr. Cooperstock's uncontroverted testimony on this point.

Based on the evidence presented in the Petition, we find that the combination of Rosener, Huddart, and Haupt teaches each limitation of claims 3 and 4. Petitioner has introduced persuasive evidence that a skilled artisan would have had reasons to combine the teachings of Rosener, Huddart, and Haupt with a reasonable expectation of success. We have considered Patent Owner's arguments and evidence of objective indicia of nonobviousness, but do not find it persuasive, for the reasons explained above. In sum, upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claims 3 and 4 would have been obvious over Rosener, Huddart, and Haupt.

D. Obviousness of Claims 9, 10, and 14 over Rosener, Huddart, and Price

Petitioner contends that claims 9, 10, and 14 would have been obvious over Rosener, Huddart, and Price. Pet. 65–71. Patent Owner disputes whether claims 9 and 10 would have been obvious, but does not contest Petitioner's allegations for claim 14. We find that the combination of Rosener, Huddart, and Price teaches each limitation of claims 9, 10, and 14.

Price "relates generally to collecting data from, sending data to, and/or updating software or digital data in electronic devices." Ex. 1008 ¶ 3. In one example, updated software code (including firmware) is retrieved by a computer from a data store on a network and delivered (wirelessly) to an electronic device. *Id.* ¶¶ 29, 38–39, Fig. 1. Exemplary electronic devices

include personal computers, digital cameras, TiVo-like devices, and personal digital assistants (such as Palm and Pocket PC devices). *Id.* ¶¶ 25, 33.

Claim 9 depends from claim 1 and adds "the processor circuits of the headphones are configured to receive firmware upgrades transmitted from a remote network server." Claim 10 depends from claim 9 and adds "wherein the headphone[s] are configured to receive the firmware upgrades wirelessly."

As to claims 9 and 10, Petitioner contends that Price teaches a coordinating computer obtaining software update code representing firmware upgrades from a server and transmitting those firmware upgrades to devices wirelessly. Pet. 69–71 (citing Ex. 1008 ¶¶ 26, 30, 33, 37, 38). According to Petitioner, a skilled artisan would have modified Rosener's transceiver 900 to implement processing related to the receipt of software update code for firmware upgrades, per the teachings of Price. *Id.* at 70 (citing Ex. 1003 ¶ 124). Petitioner argues that this feature of Price would have "provided the benefits of improving reliability, functionality, or compatibility" to Rosener's earphones. *Id.* at 70 (citing Ex. 1008 ¶¶ 5, 11; Ex. 1003 ¶¶ 124, 125).

In arguments similar to those presented for claim 18, discussed above, Patent Owner contends that "a [person of ordinary skill in the art] would not have attempted to use a low-power, pocket-charger-rechargeable battery as in Huddart, with wireless earphones that have the additional power consumption associated with receiving firmware upgrades, including wirelessly with respect to claim 10." PO Resp. 32–33 (citing Ex. 2035 ¶ 65). Here, Patent Owner mischaracterizes Petitioner's obviousness allegations as bodily incorporating Huddart's rechargeable battery into Rosener's earphone. *See also id.* at 34–35 ("As with dependent claim 18,

. . . the Petition and Cooperstock rely on Huddart's low-power earbud battery as a motivation to power the firmware-receiving earphones of claims 9 and 10. . . . Put another way, to the extent that a [person of ordinary skill in the art] might be motivated to power Rosener's earphone with Huddart's low-power, pocket-charger-rechargeable battery, neither Petitioner nor Cooperstock revisited whether the [person of ordinary skill in the art] would be motivated to use a rechargeable battery, like Huddart's low-power, pocket-charger-rechargeable battery, in a wireless headphone that additionally receives firmware upgrades (including wirelessly)."); Reply 28 n.3 ("[Patent Owner] misinterprets the Petition as incorporating Huddart's battery into Rosener"). This argument is unpersuasive, as Patent Owner's attempt to recast Petitioner's argument as a physical substitution of elements fails to take into account the teachings of Rosener and Huddart. *See Mouttet*, 686 F.3d at 1332–33.

Patent Owner further argues that "updating a device's firmware requires that the device be sufficiently powered throughout the firmware upgrade process," and that "[o]ften, if the device loses power during the firmware upgrade process, the device can become inoperable (a so-called 'brick')." PO Resp. 33. Patent Owner then argues that the '325 patent's solution is to implement the transceiver circuit on a single integrated circuit (IT), which it refers to as system-on-chip (SoC or SOC), implying that a SoC design is required by the patent's claims. *Id.* at 35–36 (citing Ex. 1001, 6:45–49; Ex. 2035 ¶¶ 70–71); *see also* Sur-reply 17–18 ("[T]the [Patent Owner Response's] description of the SOC described in the '325 Patent demonstrates how the '325 Patent enables a wireless earphone with a rechargeable battery to receive firmware upgrades."). According to Patent Owner, without a teaching of "an earphone with a SoC for reduced power

consumption," a person of ordinary skill in the art "would realize that for claims 9 and 10, the battery would need to power non-SOC wireless earphones throughout the firmware update process; and if the battery ran out of power, the wireless earphones likely would become 'bricked.'" PO Resp. 35–36. Patent Owner concludes:

> If a [person of ordinary skill in the art] were truly motivated to use small, low-power rechargeable batteries in Rosener, the [person of ordinary skill in the art] would want to keep power requirements low by implementing lower power receiver technologies (like magnetic inductance or Bluetooth), and not additionally burdening the low power rechargeable battery with having to power the wireless device throughout a firmware update.

Id. at 36–37 (citing Ex. 2035 ¶ 72).

Petitioner faults Patent Owner for not presenting evidence showing that firmware upgrades involve significant power consumption. Reply 27. In any case, Petitioner argues, a skilled artisan would have known how to implement a Rosner-Huddart-Price combination in a way that does not require high power consumption, such as incrementally upgrading firmware. *Id.* at 29–30 (citing Ex. 1023 ¶¶ 50–51). In its Sur-reply, Patent Owner changes its argument, contending instead that it is the reliability of the

battery, rather than its power, that poses the risk of a device "becoming a brick." Sur-reply 17.[11]

Patent Owner's arguments are unpersuasive. First, as Petitioner argues (Reply 28), Patent Owner points to no persuasive evidence that the claims of the '325 patent require a SoC design for a transceiver. Mr. McAlexander's testimony, which merely copies the Patent Owner Response without identifying any basis for the testimony, is of little value. Ex. 2035 ¶¶ 70–72. Moreover, the '325 patent makes clear that a SoC design is only an example. Ex. 1001, 1001, 6:45–49 ("In various embodiments, the transceiver circuit 100 may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone 10, which is advantageous if the earphone 10 is to be relatively small in size.").

Second, Patent Owner's argument that the power source must be high-power or reliable assumes that the battery would be used for the entire firmware upgrade process, including both receiving the firmware update and installing it. PO Resp. 33. Claim 9 only recites a processor circuit "configured to receive firmware upgrades," and says nothing about installing firmware. Patent Owner provides no persuasive argument or evidence suggesting that a high-power or more reliable battery would be necessary to

[11] Patent Owner repeatedly argued in its Response that it was the "low-power" nature of Huddart's battery that made it unsuitable for firmware upgrades. PO Resp. 32–37. Patent Owner's mention of an "unreliable power source" was in the context of Huddart's battery being low power. *Id.* at 37; *see also id.* at 30 (arguing that Huddart's "low-power battery" would be "unreliable" "due to its small capacity"). We decline to consider Patent Owner's new argument that Huddart's battery would have been unreliable. However, even if we did, it would not be persuasive, as we explain.

receive firmware, or that a power failure while receiving firmware (as opposed to a power failure during installation of the firmware) would result in "bricking" a device. Moreover, as Petitioner argues, a skilled artisan could have implemented the combination such that the firmware installation takes place while the earphone is connected to a charger, such as described in Huddart (primary charger and pocket charger). Reply 30–31 (citing Ex. 1023 ¶¶ 52–53; Ex. 1005, 8:28–34). Thus, even if firmware installation were required by claims 9 and 10, Patent Owner's argument still would be unpersuasive.

As explained for claims 1 and 18 (Sections II.B.3.b) and II.B.6 above), we find that a skilled artisan would have had persuasive reasons to incorporate Huddart's teaching of rechargeable batteries into Rosener's earphones, would have selected a rechargeable battery sufficient to power Rosener's circuitry (including transceiver 900, which would receive firmware upgrades), and would have had a reasonable expectation of success in doing so.

Claim 14 depends from claim 10, but otherwise adds limitations that are substantially the same as those added by claim 2. Petitioner incorporates by reference its arguments and evidence for claim 2. Pet. 71. As explained in Section II.B.4 above, we find that Rosener teaches each additional limitation of claim 2. For the same reasons, Rosener teaches each additional limitation of claim 14.

In conclusion, the combination of Rosener, Huddart, and Price teaches each limitation of claims 9, 10, and 14. Petitioner has introduced persuasive evidence that a skilled artisan would have had reasons to combine the teachings of Rosener, Huddart, and Price with a reasonable expectation of success. We have considered Patent Owner's arguments and evidence of

objective indicia of nonobviousness, but do not find it persuasive, for the reasons explained above. In sum, upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claims 9, 10, and 14 would have been obvious over Rosener, Huddart, and Price.

E. Obviousness of Claim 15 over Rosener, Huddart, and Paulson

Petitioner contends that claim 15 would have been obvious over Rosener, Huddart, and Paulson. Pet. 71–75. Patent Owner does not contest Petitioner's additional allegations for claim 15.

Paulson describes a voice communication device, such as an earphone assembly with an ear tip that inserts in the ear canal and a microphone attached at the end of a boom. Ex. 1009, 5:1–8, Figs. 1A, 1B, 2. In one example, Paulson describes a push-button switch that can be pushed to enable and mute the microphone. *Id.* at 6:18–49.

Claim 15 depends from claim 1 and adds

> wherein the processor circuit of the first earphone is configured to:
>
> > process audible utterances by the user picked by the microphone in response to activation of the microphone by the user; and
> >
> > transmit a communication based on the audible utterances via the Bluetooth wireless communication links.

Petitioner argues that Paulson's unmute feature corresponds to enabling a microphone and processor circuit to "process audible utterances by the user picked by the microphone in response to activation of the microphone by the user," as recited in claim 15. Pet. 73–74 (citing Ex. 1009, 6:18–49). Petitioner cites Rosener for the ability to "transmit a

communication based on the audible utterances via the Bluetooth wireless communication links," as recited in claim 15. *Id.* at 74–75 (citing Ex. 1004 ¶¶ 11, 35, 49, 56). According to Petitioner and Dr. Cooperstock (Pet. 73; Ex. 1003 ¶ 71), a skilled artisan would have combined Paulson's and Rosener's features in light of Paulson's statements that its "feature is important for users in a noisy environment, to allow them to reduce the noise heard by the distant party." Ex. 1009, 6:33–35. We credit Dr. Cooperstock's uncontested testimony on this point.

In light of Petitioner's evidence, we find that the combination of Rosener, Huddart, and Paulson teaches each limitation of claim 15. Petitioner has introduced persuasive evidence, including Dr. Cooperstock's testimony, that a skilled artisan would have had reasons to combine the teachings of Rosener, Huddart, and Price with a reasonable expectation of success. We have considered Patent Owner's arguments and evidence of objective indicia of nonobviousness, but do not find them persuasive for the reasons explained above. In sum, upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claim 15 would have been obvious over Rosener, Huddart, and Paulson.

F. Obviousness of Claims 16 and 17 over Rosener, Huddart, and Vanderelli

Petitioner contends that claims 16 and 17 would have been obvious over Rosener, Huddart, and Vanderelli. Pet. 75–78. Patent Owner does not contest Petitioner's additional allegations for this ground.

Vandereilli describes a wireless power supply that rectifies RF energy and stores it in a group of capacitors. Ex. 1010, Abstract, 2:1–51, 4:9–17, Fig. 1.

For claim 16, Petitioner cites Vanderelli for additional examples, beyond those shown in Huddart, of "wirelessly chargeable circuit components." Pet. 77. As explained above, we conclude that claim 16 would have been obvious over Rosener and Huddart. Thus, we do not reach whether claim 16 also would have been obvious over Rosener, Huddart, and Vanderelli. *See SAS*, 138 S. Ct. at 1359); *Bos. Sci. Scimed*, 809 F. App'x at 990.

As to claim 17, Petitioner contends that a "passive, wireless rechargeable power source" is a rechargeable power source that "may comprise capacitors passively charged with RF radiation." Pet. 51 (quoting Ex. 1001, 7:3–5; citing Ex. 1003 ¶ 104), 78 (quoting Ex. 1001, 7:3–5; citing Ex. 1003 ¶ 134). Petitioner contends that a skilled artisan would have incorporated Vanderelli's technique of rectifying RF energy and storing it in capacitors because it would have provided the "advantages of obtaining energy from a range of RF frequencies." *Id.* at 78 (citing Ex. 1003 ¶ 134). We credit Petitioner's evidence, including Dr. Cooperstock's uncontested testimony.

In light of Petitioner's evidence, we find that the combination of Rosener, Huddart, and Vanderelli teaches each limitation of claim 17. Petitioner has introduced persuasive evidence, including Dr. Cooperstock's testimony, that a skilled artisan would have had reasons to combine the teachings of Rosener, Huddart, and Vanderelli with a reasonable expectation of success. We have considered Patent Owner's arguments and evidence of objective indicia of nonobviousness, but do not find it persuasive, for the reasons explained above. In sum, upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claim 17 would have been obvious over Rosener, Huddart, and Vanderelli.

III. CONCLUSION[12]

Petitioner has shown by a preponderance of the evidence that claims 1–4, 9, 10, and 14–17 would have been obvious. Petitioner has not shown by a preponderance of the evidence that claim 18 would have been obvious.

In summary:[13]

Claims	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 16–18	103(a)	Rosener, Huddart	1, 2, 16	18
3, 4	103(a)	Rosener, Huddart, Haupt	3, 4	
9, 10, 14	103(a)	Rosener, Huddart, Price	9, 10, 14	
15	103(a)	Rosener, Huddart, Paulson	15	
16, 17	103(a)	Rosener, Huddart, Vanderelli	17	
Overall Outcome			1–4, 9, 10, 14–17	18

[12] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

[13] For the reasons explained above, we do not reach whether claim 17 would have been obvious over Rosener and Huddart, or whether claim 16 would have been obvious over Rosener, Huddart, and Vanderelli.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED, based on a preponderance of the evidence, that claims 1–4, 9, 10, and 14–17 have been shown to be unpatentable;

FURTHER ORDERED, based on a preponderance of the evidence, that claim 18 has not been shown to be unpatentable; and

FURTHER ORDERED, because this is a final written decision, the parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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Paper 43
Date: June 27, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE, INC.,
Petitioner,

v.

KOSS CORPORATION,
Patent Owner.

IPR2021-00381
Patent 10,491,982 B1

Before DAVID C. McKONE, GREGG I. ANDERSON, and NORMAN H. BEAMER, *Administrative Patent Judges*.

ANDERSON, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Apple, Inc. ("Petitioner") filed a Petition requesting *inter partes* review of claims 1–5 and 14–20 of U.S. Patent No. 10,491,982 (Ex. 1001, "the '982 patent"). Paper 2 ("Pet."). Koss Corporation ("Patent Owner") filed a Preliminary Response. Paper 10 ("Prelim. Resp."). Upon our authorization, Petitioner filed a Preliminary Reply relating to discretionary denial based on the factors set forth in *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential). Paper 11 ("Prelim. Reply"). Patent Owner filed a Preliminary Sur-Reply. Paper 12 ("Prelim. Sur-Reply"). We instituted *inter partes* review on July 2, 2021. Paper 15 ("Inst. Dec."). Patent Owner filed a Response (Paper 19, "PO Resp."), Petitioner filed a Reply (Paper 31, "Reply"), and Patent Owner filed a Sur-Reply (Paper 34, "Sur-Reply"). A hearing was held on April 5, 2022, and a transcript has been made of record. Paper 42 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Decision is a final written decision under 35 U.S.C. § 318(a) as to the patentability of claims 1– 5 and 14–20. Based on the record before us, Petitioner has proved, by a preponderance of the evidence, that claims 1–5 and 14–18 are unpatentable, but has not proved that claims 19 and 20 are unpatentable.

II. BACKGROUND

A. Real Parties in Interest

Petitioner states it is the real party-in-interest. Pet. 85. Patent Owner states it is the real party-in-interest. Paper 4 ("Mandatory Notice by Patent Owner"), 1; *see also* Papers 6–9 (Updates to Mandatory Notice).

B. Related Matters

Both parties list a related lawsuit alleging infringement of the '982 patent, *Koss Corporation v. Apple Inc.*, Case No. 6:20-cv-00665 (W.D. Tex.) ("District Court Lawsuit"). Pet. 86. Patent Owner lists the District Court Lawsuit and other lawsuits involving the '982 patent, United States applications to which the '982 patent claims priority, and pending *inter partes* reviews as Related Matters. Paper 9, 1–2.

1. Other Lawsuits

Patent Owner identifies five other lawsuits involving the '982 patent: *Koss Corporation v. PEAG LLC d/b/a JLab Audio*, Case No. 6:20-cv-00662 (W.D. Tex.); *Koss Corporation v. Skullcandy, Inc.*, Case No. 6:20-cv-00664 (W.D. Tex); *Apple Inc. v. Koss Corporation*, Case No. 4:20-cv-05504 (N.D. Cal.); *Koss Corporation v. Apple Inc.*, Case No. 6-20-cv-00665 (W.D. Tex.); and *Koss Corporation v. Skullcandy, Inc.*, Case No. 2:21-cv-00203 (D. Utah). Paper 9, 1.

2. United States Applications

Patent Owner lists the following as Related Applications to which the '982 patent claims priority: PCT application No. PCT/US2009/039754, filed April 7, 2009 (the "PCT Application") and provisional application Serial No. 61/123,265, filed April 8, 2008 (the "Provisional Application"). Paper 9, 1.

3. Inter Partes Review Proceedings

Patent Owner lists the following *inter partes* review proceedings[1] challenging patents that claim priority to the PCT Application and the Provisional Application:

Bose Corporation v. Koss Corporation, IPR2021-00297, filed December 7, 2020, challenging US Patent 10,368,155 B2;

Apple Inc. v. Koss Corporation, IPR2021-00305, filed December 15, 2020, challenging US Patent 10,506,325 B1;

Apple Inc. v. Koss Corporation, IPR2021-00546, filed February 22, 2021, challenging US Patent 10,206,025 B2;

Apple Inc. v. Koss Corporation, IPR2021-00592, filed March 2, 2021, challenging US Patent 10,469,934 B2;

Apple Inc. v. Koss Corporation, IPR2021-00612, filed March 3, 2021, challenging U.S. Patent 10,206,025;

Apple Inc. v. Koss Corporation, IPR2021-00626, filed March 17, 2021, challenging US Patent 10,206,025 B2;

Bose Corporation v. Koss Corporation, IPR2021-00680, filed March 17, 2021, challenging US Patent 10,469,934 B2;

Apple Inc. v. Koss Corporation, IPR2021-00679, filed March 22, 2021, challenging US Patent 10,506,325 B1; and

[1] *Apple Inc. v. Koss Corporation*, IPR2021-00255, filed November 25, 2020, and *Apple Inc. v. Koss Corporation*, IPR2021-00600, filed March 7, 2021, both challenging US Patent 10,298,451 B1, and *Apple Inc. v. Koss Corporation*, IPR2021-00686, filed March 22, 2021, challenging US Patent 10,491,982 B1, are also pending *inter partes* reviews between these same parties.

Apple Inc. v. Koss Corporation, IPR2021-00693, filed March 23, 2021, challenging US Patent 10,469,934 B2.

Paper 9. 1–2.

C. The '982 Patent

The application for the '982 patent's earliest priority dates are April 7, 2009, to the PCT Application and April 8, 2008[2], to the Provisional Application. Ex. 1001, codes (60), (63). See Section II.B.2 above.

1. Background Technology

The '982 patent explains that wired headphones interconnecting headphones and a data storage unit are "cumbersome." Ex. 1001, 1:56–59. "Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but "such headphones are also quite large and not in-ear type phones." *Id.* at 1:66–2:4.

2. The '982 Patent's Wireless Earphones

The '982 patent describes and claims "a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks." Ex. 1001, 2:64–66. "[T]he earphone may transition automatically from an ad hoc wireless network to an infrastructure wireless network, without user intervention." *Id*. at 3:8–11. The '982 patent defines "ad hoc wireless network" as "a network where two . . . wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point." *Id.* at 3:8–14. The '982 patent defines "infrastructure wireless network" as "a wireless network that uses

[2] The priority date is not in dispute. See Pet. 2.

one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet)." *Id*. at 3:14–19.

Two discrete wireless earphones are described, each having a body and an "ear canal portion for insertion into the canal of the user of the earphone." *Id.* at 3:25–27, 3:54–56. Figure 2A of the '982 patent is reproduced below.

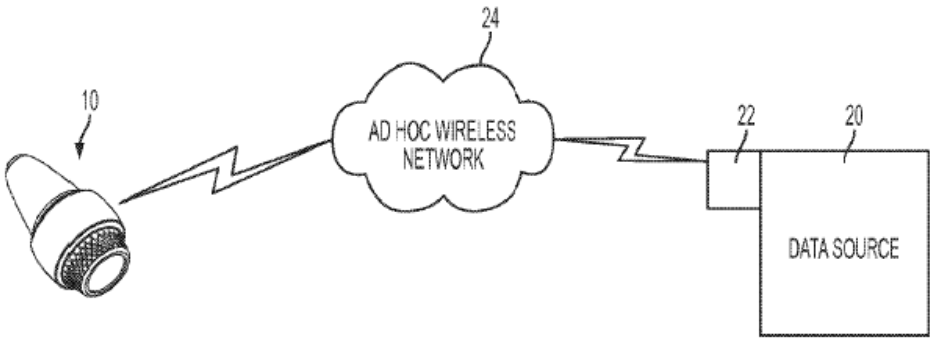


FIG. 2A

Figure 2A illustrates one of the communication modes for the wireless earphone.

Ex. 1001, 2:36–38. Figure 2A illustrates a wireless network adapter 22 connected to a data source 20 in communication with earphone 10 over ad hoc wireless network 24. *Id.* at 4:33–37. The earphone has a transceiver circuit to communicate wirelessly with a data source. *Id.* at 4:35–37. The data source may be a digital audio player (DAP). *Id.* at 4:39–40. The DAP transmits audio wirelessly to earphone(s) via an ad hoc network if the DAP and earphone(s) are "in range" of that network. *Id.* at 4:63–65. "When in range, the data source 20 may communicate with the earphone 10 via the ad

hoc wireless network 24 using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.lla/b/g/n), WiMAX (IEEE 802.16), Bluetooth" and other communication protocols. *Id.* at 4:63–5:1.

Figure 2B of the '982 patent is reproduced below.

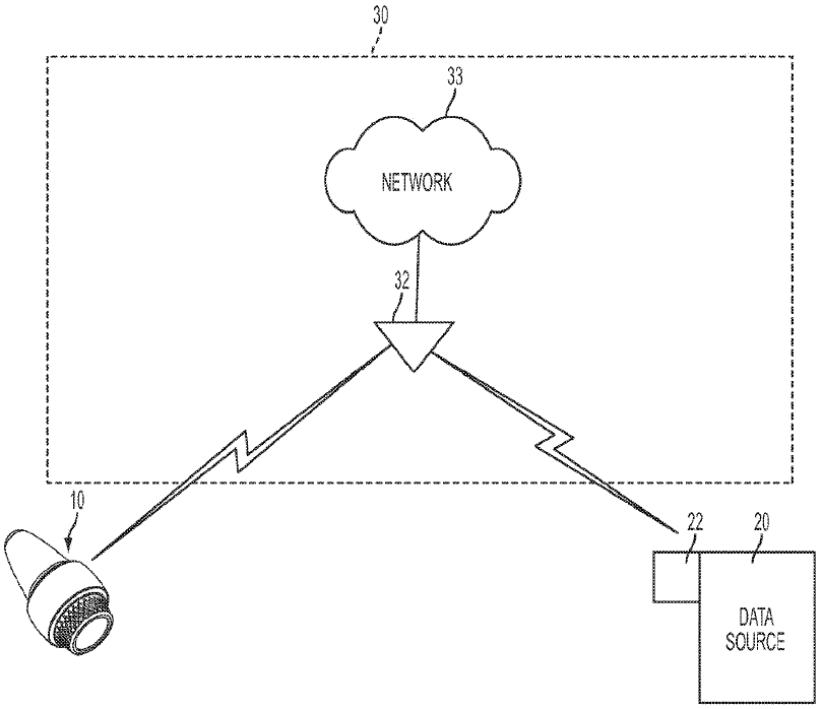


FIG. 2B

Figure 2B illustrates another of the communication modes for the wireless earphone.

Ex. 1001, 2:36–38. The data source and wireless network adapter may transmit digital audio wirelessly through an access point 32 over "an infrastructure wireless network (such as a wireless LAN (WLAN) 30". *Id.* at 4:34–40. "[T]he wireless network adapter 22 may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source 20 (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network

(e.g., the ad hoc wireless network 24 or an infrastructure wireless network)." *Id*. at 4:50–56.

D. Illustrative Claim

Claims 1–5 and 14–20 of the '982 patent are challenged. Pet. 1–2, 18–85. Claim 1 is the only independent claim challenged. Claims 2–5 and 14–20 depend directly or indirectly from claim 1. All claims are directed to a "system." Claim 1 is reproduced below as illustrative.

[1.P][3] 1. A system comprising:

[1.a] headphones comprising a pair of first and second wireless earphones to be worn simultaneously by a user,

[1.b] wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected,

[1.c] wherein each of the first and second earphones comprises:

[1.c.i] a body portion that comprises:

[1.c.i.A] a wireless communication circuit for receiving and transmitting wireless signals;

[1.c.i.B] a processor circuit in communication with the wireless communication circuit; and

[1.c.i.C] an ear canal portion that is inserted into an ear of the user when worn by the user; and

[3] For purposes of this Decision, we follow Petitioner's format where each claim is identified by claim number followed by a letter or combination of letters and Roman numerals for each limitation. *See* Pet. 32–53 (limitations 1.P– 1.d).

[1.c.i.D] at least one acoustic transducer connected to the processor circuit; and

[1.c.ii] an elongated portion[4] that extends away from the body portion such that the elongated portion extends downwardly when the ear canal portion is inserted in the ear of the user;

[1.c.iii] a microphone connected to the processor circuit and for picking up utterances of a user of the headphones;

[1.c.iv] an antenna connected to the wireless communication circuit; and

[1.c.v] a rechargeable power source; and

[1.d] a mobile, digital audio player that stores digital audio content and that comprises a wireless transceiver for transmitting digital audio content to the headphones via Bluetooth wireless communication links, such that each earphone receives and plays audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player.

Ex. 1001, 18:8–40.

E. Evidence of Record

This proceeding relies on the following prior art references and expert testimony:

Rosener, US 2008/0076489 A1, published Mar. 27, 2008 (Ex. 1004);

[4] This limitation recites "elongated portion," which does not appear in the Specification.

Hankey, US 2008/166001 A1, published July 10, 2008 (Ex. 1005);

Dyer, US 8,031,900 B2, issued Oct. 4, 2001 (Ex. 1006);

Huddart, US 7,627,289 B2, issued Dec. 1, 2009 (Ex. 1007);

Hankey Provisional,[5] US 60/879,177, filed Jan. 6, 2007 (Ex. 1008);

Price, US 2006/0026304 A1, published Feb. 2, 2006 (Ex. 1009);

Paulson, US 7,551,940 B2, issued June 23, 2009 (Ex. 1010);

Marek, US 5,371,454, issued Dec. 6, 1994 (Ex. 1011);

Vanderelli, US 7,027,311 B2, issued Apr. 11, 2006 (Ex. 1012); and

Haupt, EP 2006/042749 A2, issued Apr. 27, 2006 (Ex. 1020, including English translation).

Petitioner also relies on the Declaration of Dr. Jeremy Cooperstock (Ex. 1003, "Cooperstock Declaration") and the Supplemental Declaration of Dr. Jeremy Cooperstock (Ex. 1024, "Cooperstock Supplemental Declaration").

Patent Owner relies on the Declaration of Joseph C. McAlexander III (Ex. 2038, "McAlexander Declaration") and the Declaration of Nicholas S. Blair (Ex. 2039, "Blair Declaration").

F. Prior Art and Asserted Grounds

Petitioner asserts that claims 1–5 and 14–20 would have been unpatentable on the following grounds (Pet. 1–2, 18–85):

[5] Hankey Provisional is a US provisional application related to Hankey. *See* Ex. 1005 code (60).

Claim(s) Challenged	35 U.S.C. §[6]	Reference(s)/Basis
1, 2, 18–20	103	Rosener, Hankey or Rosener, Hankey, Dyer
3–5	103	Rosener, Hankey, Haupt or Rosener, Hankey, Dyer, Haupt
14	103	Rosener, Hankey, Price or Rosener, Hankey, Dyer, Price
15	103	Rosener, Hankey, Paulson or Rosener, Hankey, Dyer, Paulson
16–17	103	Rosener, Hankey, Huddart or Rosener, Hankey, Dyer, Huddart
17	103	Rosener, Hankey, Huddart, Vanderelli or Rosener, Hankey, Dyer, Huddart, Vanderelli

III. ANALYSIS

A. Level of Ordinary Skill in the Art

Petitioner's expert Dr. Cooperstock, testifies that, based on his experience and the references used to challenge the '982 patent, a person of ordinary skill in the art at the time of the critical date for the '982 patent

> would have had at least a Bachelor's Degree in an academic area emphasizing electrical engineering, computer science, or a similar discipline, and at least two years of experience in wireless communications across short distance or local area networks. Superior education could compensate for a deficiency in work experience, and vice-versa.

[6] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103, effective March 16, 2013. Because the application that resulted in the '982 patent has an effective filing date before this date, the pre-AIA versions of §§ 102 and 103 apply.

Ex. 1003 ¶ 30. This level of skill was adopted in the Institution Decision. Inst. Dec. 33. Patent Owner agrees we "should maintain this standard for the proceeding as Patent Owner agrees that it is an appropriate standard." PO Resp. 5–6 (citing Ex. 2038 ¶ 20). At the Final Hearing, all parties agreed the above level of skill is the correct one for this proceeding. Tr. 73:1–74:13.

Dr. Cooperstock's proposal is consistent with the level of ordinary skill in the art reflected by the prior art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). As per the agreement of the parties, including their experts, and consistent with the prior art, we adopt the above level of ordinary skill for this Decision.

B. Claim Construction

The Petition was accorded a filing date of January 4, 2021. Paper 5. For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100 (2019). Thus, we apply the claim construction standard as set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

Petitioner cites 37 C.F.R. § 42.100, asserts construction is unnecessary, and does not propose any term for express construction in the claim construction section of the Petition. Pet. 18. Notwithstanding the preceding, Petitioner raises a construction issue with respect to claim 17's

recitation of "passive, wireless rechargeable power source." Pet. 80–81. We preliminarily agreed with Petitioner's proposed construction and determined that a "passive" power source 102 "may comprise capacitors passively charged with RF radiation." Inst. Dec. 34 (citing Pet. 80–81 (quoting Ex. 1001, 7:7–9)[7]). Patent Owner does not dispute our preliminary construction or identify any other claim term for express construction. *See generally* PO Resp.

The papers filed since institution do not raise a dispute regarding "passive, wireless rechargeable power source." For completeness of the record, we maintain our preliminary construction of "passive, wireless rechargeable power source." We also determine construction is unnecessary for any other claim term in order to resolve the dispute. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy."). On all other claim terms we proceeded based on the plain and ordinary meaning as understood by a person of ordinary skill in the art. Inst. Dec. 34.

C. Legal Standard for Obviousness

A patent claim is invalid as obvious if the differences between the claimed subject matter and the prior art are "such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. § 103(a).

> The ultimate determination of obviousness is a question of law, but that determination is based on underlying factual

[7] The Cooperstock Declaration does not provide a construction for any claim term. *See* Ex. 1003 ¶ 29.

> findings. . . . The underlying factual findings include (1) "the scope and content of the prior art," (2) "differences between the prior art and the claims at issue," (3) "the level of ordinary skill in the pertinent art," and (4) the presence of secondary considerations of nonobviousness such "as commercial success, long felt but unsolved needs, failure of others," and unexpected results.

In re Nuvasive, Inc., 842 F.3d 1376, 1381 (Fed. Cir. 2016) (citing *inter alia*, *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)).

"To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Furthermore, in assessing the prior art, the Board must consider whether a person of ordinary skill would have been motivated to combine the prior art to achieve the claimed invention. *Nuvasive*, 842 F.3d at 1381.

As the Federal Circuit found, in quoting from the Supreme Court's decision in *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418–419 (2007),

> because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known," "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does."

Personal Web Technologies, LLC v. Apple, Inc., 848 F.3d 987, 991–92 (Fed. Cir. 2017).

D. Obviousness of Claims 1–2 and 18–20 over Rosener and Hankey or Rosener, Hankey, and Dyer[8]

Petitioner alleges claims 1–2 and 18–20 would have been obvious over Rosener and Hankey or Rosener, Hankey, and Dyer. Pet. 1, 18–58. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶¶ 16–57, 59–91.

1. Rosener (Ex. 1004)

Rosener relates to wireless communication between an external data or audio device, like a cell phone or PDA, MP3 or CD player, radio personal computer or game console, and first and second earphones. Ex. 1004 ¶¶ 1, 30. Rosener explains that conventional wireless earphones came in different designs, each with "its own unique benefits and drawbacks." *Id.* ¶¶ 5–10, Figs. 2–4. Rosener focuses on wireless "earbuds." *Id.* at Abs., ¶¶ 11, 30, Fig. 5.

Each earbud is designed to fit into the concha of the pinna of the user's ear, and includes a housing containing a speaker, a radio-frequency (RF) transceiver, and a battery. Ex. 1004 ¶ 30. The transceiver of each is "configured to receive data signals over one or more single-access wireless links or over a multi-access wireless link." *Id.* ¶ 11. The Bluetooth industrial specification (IEEE 802.15.1 standard) is one communication protocol disclosed that allows each of the earphones to communicate with the external data or audio data devices. *Id.* ¶¶ 4, 35.

[8] We have analyzed commercial success for all challenges. See Section III.J below.

Figure 9, reproduced below, illustrates some of the components of Rosener's headphones:

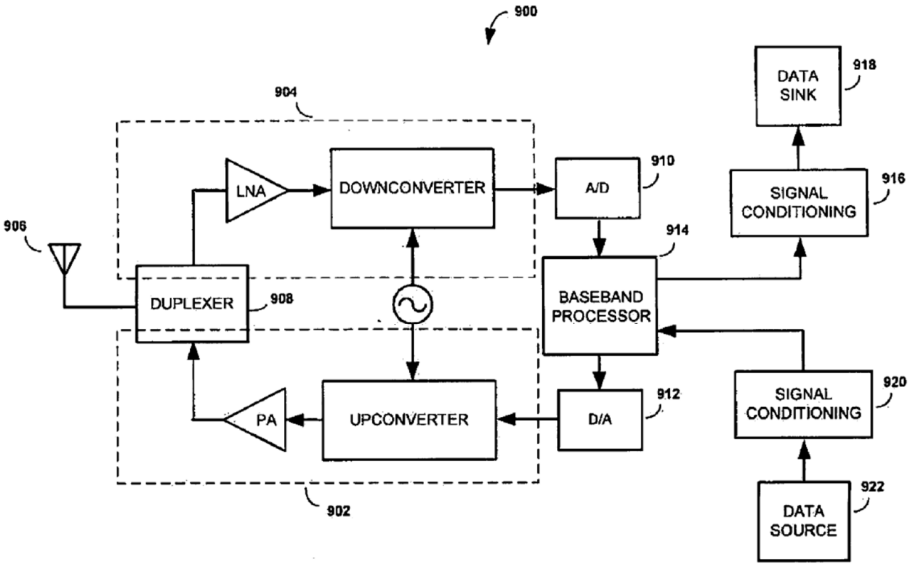


FIGURE 9

Figure 9 is a block diagram of an RF transceiver.

Ex. 1004 ¶¶ 24, 49. As shown above, RF transceiver 900 includes RF transmitter portion 902, RF receiver portion 904, antenna 906, and duplexer 908. *Id.* ¶ 49. A/D converter 910 receives analog baseband signals from RF transceiver portion 904, digitizes the signals, and sends them to baseband processor 914, which, along with signal conditioning circuit 916, processes the signals into a form suitable to drive data sink (speaker) 918. *Id.* Baseband processor 914 receives data from data source 922 (e.g., a microphone) via signal conditioning circuit 920 and provides the data to RF transmitter portion 902 for transmission via antenna 906. *Id.* 1650.

2. Hankey[9] (Ex. 1005)

Hankey describes a headset within "a small compact unit." Ex. 1005 ¶¶ 93, 103. The techniques disclosed in Hankey include integrating electronic components/assemblies (e.g., speaker, antenna) into the limited volume of a small headset, by dividing the headset's electronic components/assemblies "into small multiple [groups of] components that can be positioned at different locations (discretely) within the headset." *Id.* ¶ 98. Similarly, "electronic assemblies that are partially flexible or bendable such that the assemblies can be folded into a small compact form in order to fit inside tightly spaced internal volumes." *Id.* ¶ 99.

Hankey divides the headset's electronic components/assemblies between the earbud and the primary housing. Ex. 1005 ¶¶ 130–131. For example, the processor and speaker may be placed inside the earbud while the microphone "can be electrically coupled to primary housing flexible circuit board." *Id.* ¶ 131.

Figures 10A and 10B of Hankey are reproduced below.

[9] In describing Hankey, Petitioner also cites to Ex. 1008, the Hankey Provisional. Pet. 21; Ex. 1005, code (60); Section II.E above. Petitioner cites to the Hankey Provisional to prove "Hankey is entitled to the benefit of its provisional filing date, *i.e.*, the January 6, 2007 filing date." Pet. 3 (quoting Ex. 1003 ¶ 43; citing Ex. 1008 ¶¶ 89–90, 208–212, Figs 1A, 40A, 41–44). We cite only to Hankey, not the Hankey Provisional. Patent Owner does not dispute that Hankey is prior art and we find the filing date of the Hankey Provisional is the priority date for Hankey.

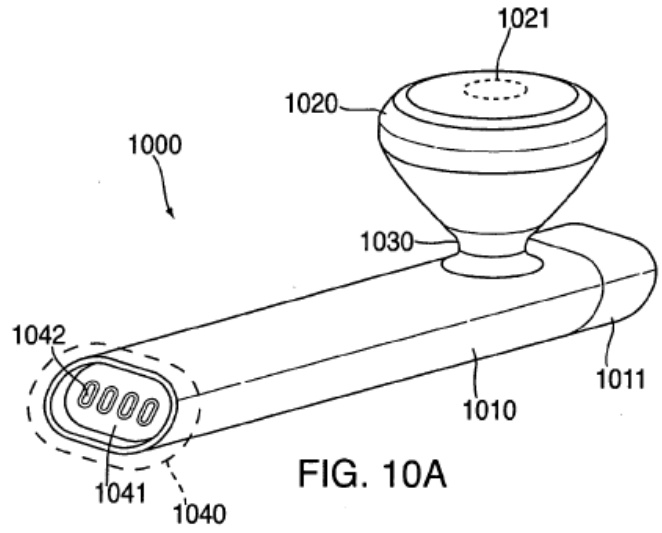


FIG. 10A

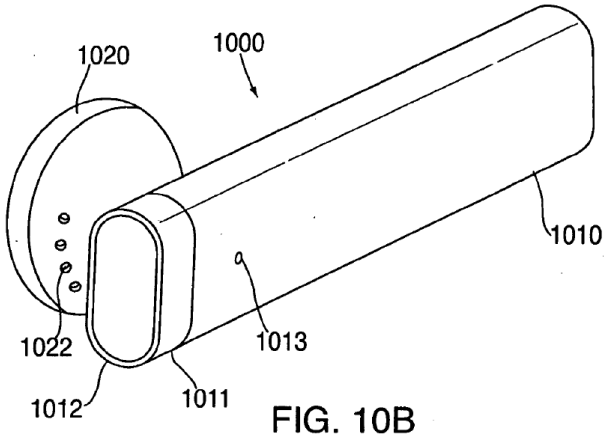


FIG. 10B

Figures l0A and 10B are perspective views of Hankey's headset.

Ex. 1005 ¶ 143. Figure 10A shows headset 1000 for enclosing "electronic and other elements of the headset." *Id.* ¶ 144. The headset "can include earbud 1020, neck 1030, primary housing 1010, antenna cap 1011 and connector 1040." *Id.* "Earbud 1020 can include perforations (e.g., acoustic ports) 1021 and 1022 for allowing air to pass into and out of the earbud 1020." *Id.* "Front port 1021 can allow sound waves from a receiver located in earbud 1020 to reach a user's ear and/or the outside environment." *Id.* Button 1012 can control the headset. *Id.* ¶ 145.

3. Dyer (Ex. 1006)

Dyer describes a "canalphone" type including an eartip that fits within a user's ear canal. Ex. 1006, 3:4–6, 4:37–39, Fig. 1. The eartip is "attachable to a standard generic earphone." *Id.* at 1:10–11, 2:21–24.

Dyer's Figure 1 is reproduced below.

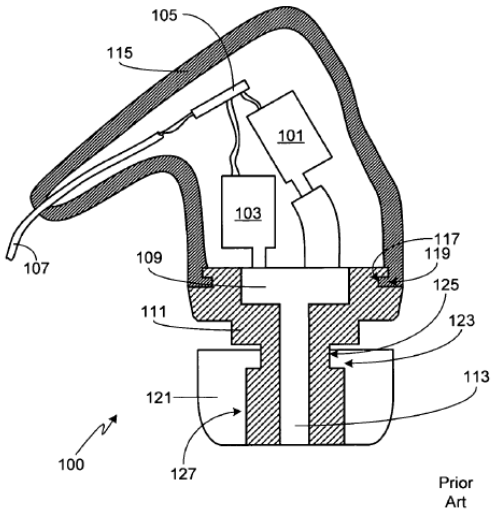


FIG. 1

Figure 1 is a cross-sectional view of a generic earphone in accordance with the prior art.

Ex. 1006, 2:48–49. Figure 1 illustrates an example of "canalphone" 100 that includes a sound delivery member 111 with an eartip 121 attached to an end portion of it. *Id.* at 3:4–6, 3:26–28, 4:4–14. Sound delivery member 111 is attached to earphone enclosure 115 that protects "any required earphone circuitry" of canalphone 100 from damage. *Id*. at 3:57–66. Intermediary member 111 includes a sound delivery tube 113 that delivers audio from circuitries in enclosure 115 to eartip 121. *Id.* at 3:22–25.

4. Claim 1

Patent Owner disputes that a person of ordinary skill, as determined above in Section III.A, would have had sufficient skill to combine Rosener and Hankey with a reasonable expectation of success. PO Resp. 12–21. Patent Owner disputes the reasons for combining Rosener, Hankey, and Dyer. *Id*. at 34–40. Patent Owner also disputes that the Rosener and Hankey or Rosener, Hankey, and Dyer combinations teach two wireless earphones, each having a microphone. *Id*. at 21–34.

a. Rosener and Hankey Reasons for the Combination and Expectation of Success

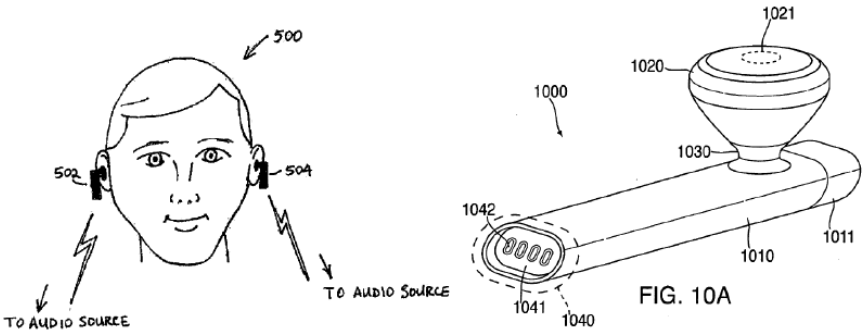
Petitioner's reasons for combining Rosener and Hankey start with Rosener's teaching of "providing 'high-quality stereo,' i.e., binaural, functionality." Pet. 24 (citing Ex. 1004 ¶¶ 30, 3–8, Fig. 5; Ex. 1003 ¶ 44). Petitioner relies on Rosener as teaching two "earpieces/earphones" 502 and 504 in wireless communication with an "audio source." *Id*. at 25 (citing Ex. 1004, Fig. 5; *see also id.* ¶ 30 (describing Fig. 5)). Petitioner relies on Hankey for details of the form factor for the earphones 502 and 505, thus implementing the combination of Rosener's earphones and Hankey's "small compact earpiece[s]."[10] Pet. 25–27 (citing Ex. 1003 ¶¶ 45, 47). Petitioner argues "Hankey considers the size and weight of prior art headsets as a 'key issue' that causes an uncomfortable fit of the headsets on a user's ear." *Id*. at 26 (citing Ex. 1005 ¶ 11; Ex. 1008[11] ¶ 3). Petitioner

[10] Hankey uses the term "headset" but Petitioner uses "earpiece" for "consistency and to avoid confusion." *See* Pet. 24, n.6. We find that convention reasonable and adopt it here.

[11] Sanford, US Provisional Application No. 60/879,177, filed Jan. 6, 2007 (Ex. 1008). Provisional application for Hankey. *See* Ex. 1005 code (60).

argues that "Hankey discloses a compact earpiece capable of communicating with external audio devices wirelessly." *Id*. (citing Pet. 22–23 (describing Hankey)).

Petitioner argues Hankey "provides techniques to package electronics within 'a small compact unit' to alleviate the size and shape hassles of conventional headsets." Pet. 26 (citing Ex. 1005 ¶¶ 92–98; Ex. 1008 ¶¶ 93, 144–150). Petitioner alleges a person of ordinary skill in the art would have been motivated to arrange the components of Hankey in a "small, compact form factor" as shown in Figure 5 of Rosener. *Id*. (citing Ex. 1003 ¶ 46). Petitioner provides a side-by-side comparison of Rosener's Figure 5 as compared to Hankey's Figure 10A, which is reproduced below.



Petitioners compare shows Rosener's Figure 5 on the left and Hankey's Figure 10A on the right.

Pet. 27. Petitioner alleges a person of ordinary skill in the art "would have recognized the similarities between the earpieces shown in Hankey's FIGs. 5 or 10A and earphones 502, 504 shown in Rosener's FIG. 5, and would have been motivated to use Hankey's component arrangement techniques to implement internal components and external features of earphones 502, 504." *Id*. at 27–28 (citing Ex. 1003 ¶ 48).

Petitioner alleges Rosener's earphones 502, 504 are "physically and electrically" separate and a person of ordinary skill in the art "would have

recognized that Hankey's techniques are readily applicable to Rosener's earphones 502, 504." Pet. 28 (citing Ex. 1004 ¶ 30). Dr. Cooperstock is relied on for his testimony that latency compensation processing would "enable stereo play when both earphones are being simultaneously used." *Id*. at 28–29 (citing Ex. 1004 ¶¶ 11, 39–42; Ex. 1003 ¶ 49).

We find that Petitioner has shown sufficiently that a person of ordinary skill in the art would have had reason to combine Hankey's "small form factors" with Rosener's earphones. Pet. 25–29. Patent Owner argues stereo input by the microphones to the earphones is an insufficient reason for the combination and the Cooperstock Deposition testimony supporting it is speculative. PO Resp. 32 (citing Ex. 2037, 104:12–18). Mr. McAlexander testifies Rosener is intended for "communication purposes" and not music. Ex. 2038 ¶ 71. Mr. McAlexander testifies that Rosener and Hankey would be for communication and not "capturing high-quality, stereo audio recordings." Ex. 2038 ¶ 71; *see also* PO Resp. 32–33 (making same argument).

Patent Owner also argues a second microphone (see Section III.D.4.c below, analyzing the "microphone limitation") would "add significant complexity" to the combination. PO Resp. 33 (citing Ex. 2038 ¶ 73). The argument is based on the earphones being physically spaced apart, along with the associated microphone, resulting in different signal strengths. *Id*. at 34 (citing Ex. 2038 ¶ 74). Thus, there is a need to determine which signal is stronger for communication with the external device. *Id*. at 33–34 (citing Ex. 2038 ¶ 74). According to Patent Owner, the need to accommodate the difference in signal strength requires additional signal processing and complexity. *Id*. at 34 (citing Ex. 2038 ¶ 74). Patent Owner

concludes by arguing a person of ordinary skill in the art "would not modify the Rosener-Hankey combination (or Rosener-Hankey-Dyer combination) to include a microphone in each earphone." *Id*. (emphasis omitted).

We adopt as our findings Petitioner's argument and evidence summarized above. We find that the addition of stereo audio reception is a reason to combine Hankey with Rosener. Rosener discloses "high quality stereo sound" with two separate earpieces/earphones. Ex. 1004 ¶¶ 10–11 ("left-ear and right-ear circum-aural over-the-ear headphones, stereo speakers, speakers for a surround sound system, etc."). "[H]igh-quality stereo sound" is an advantage over the prior art in "allowing each of the two earpieces/earphones to be 'physically and electrically separated' from the other." Ex. 1003 ¶ 44 n.2 (citing Ex. 1004 ¶¶ 10–11).

The McAlexander testimony that Rosener's microphone would be understood by a person of ordinary skill in the art as intended "exclusively for communication purposes," and not "stereo audio recordings," is not persuasive. Ex. 2038 ¶ 71. Why the alleged distinction makes a difference is not explained. The '982 patent does not discuss the difference in the context of the written description nor is it part of any claim. Indeed, Mr. McAlexander points to recent smartphone products, not the '982 patent, for their teachings of "using multiple microphones." *Id*. (examples including Apple XSW and XR).

In connection with the challenge to claim 1 based on Rosener and Hankey or Rosener, Hankey, and Dyer (this combination is analyzed in Section III.D.4.b below), Patent Owner makes several arguments that a person of ordinary skill would not have a level of skill sufficient to combine the references as Petitioner proposes. PO Resp. 1, 12–21; *see also* Pet. 24–

31 (reasons for the combination). More specifically, Patent Owner argues that Dr. Cooperstock's "experience [is] superior" to a person of ordinary skill in the art yet he does not understand the operation of the prior art, highlighting the "complexity of designing wireless earphones." PO Resp. 1; *see also id*. at 14–16 (citing Ex. 2037, 37:17–43:17 (Dr. Cooperstock "could not explain how the speaker elements disclosed in Rosener operate or even how they compare to one another.")).

Patent Owner argues a person of ordinary skill in the art "would not necessarily have any skills or knowledge specific to designing the acoustic transducer for a wireless earphone, fitting all of the components into a small form factor earphone, or suitably powering a wireless earphone given the safety and size constraints." PO Resp. 6–7 (citing Ex. 2038 ¶ 20); *see also id*. at 16 (alleging Dr. Cooperstock, has skills superior to a person of ordinary skill in the art, "could not explain how the speaker elements disclosed in Rosener operate" (citing Ex. 2037, 37:17–43:17)). Patent Owner argues a person of ordinary skill would need to overcome problems relating to the design and construction of "operative wireless earphones," including sound quality and "form factor[12]" considerations. *Id*. at 16 (citing Ex. 2038 ¶ 50).

Because of these alleged complexities as compared to the relatively low level of skill applicable here, Patent Owner argues generally that "it would not have been obvious to a [person of ordinary skill in the art] . . . to make the combinations proposed by Petitioner for claim 1." PO Resp. 18 (citing Ex. 2038 ¶ 56). Patent Owner contends specifically that Dr.

[12] We find "form factor" refers to the physical design of the "earphone." *See*, *e.g.*, Ex. 1003 ¶ 45; Ex. 2038 ¶ 20.

Cooperstock could not discern a difference between separately numbered "DATA SOURCE" 618 in Figure 6 and "DATA SOURCE" 922 in Figure 9 of Rosener. *Id*. at 19 (citing Ex. 2037, 102:21–103, 12 ("they're referring to the same data source")). Patent Owner argues the described "DATA SOURCE[S]" 618 and 922 are different. *Id*. (citing Ex. 2037, 102:10–18 (DATA SOURCE 922 could be a "sensor or a microphone.")). According to Patent Owner the "DATA SOURCE 618," which Rosener explains "may be provided from a digital audio data output of an MP3 player, CD player, PC, PDA, mobile telephone, game console, component of an entertainment system, etc." *Id*. at 19–20 (citing Ex. 2038 ¶ 68 (quoting Ex. 1004 ¶ 33)).

Patent Owner argues that Dr. Cooperstock has a skill level beyond that of the person of ordinary skill and cannot "ascertain whether data source 922 is a sensor/microphone incorporated into a wireless earphone or is a digital or audio data source like an MP3 player that is external to the wireless earphone." PO Resp. 19. As a result of this complexity, as evidenced by Dr. Cooperstock's alleged lack of understanding, Patent Owner alleges the person of ordinary skill "would not have a reasonable expectation of success implementing Rosener's headset within the compact form factor of Hankey." *Id*. at 19–20 (citing Ex. 2038 ¶ 68). Patent Owner also cites Dr. Cooperstock's inability to identify a "suitable material for the flexible electrical connector" as disclosed in Hankey. PO Resp. 20 (citing Ex. 2037, 67:1–68:4).

We agree with Petitioner and find that Rosener's Figure 5 expressly discloses "each of earphones 502, 504 ***is inserted into an ear of the user when worn by the user***. Since '[e]ach of the first and second earphones 502, 504 may be . . . a canalphone, which can be fitted within the ***ear canal***

of the user's ear,' each of the earphones has ***an ear canal portion***." Pet. 44 (citing Ex. 1003 ¶¶ 34, 109; Ex. 1004 ¶ 30) (alteration in original). Patent Owner's complexity arguments are predicated on bodily incorporation. That is not the test for obviousness. As noted below, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. *In re Keller*, 642 F.2d 413, 425 (C.C.P.A. 1981).

We agree with Petitioner and find that design and implementation details of the headphones would have been well-known, i.e., "suggested to those of ordinary skill in the art." Reply 9. As Petitioner argues specifically, a person of ordinary skill in the art would have understood how to make the claimed headphones. *Id*. (citing Ex. 1024 ¶ 13); *see also* Ex. 2037, 39:11–17 (Dr. Cooperstock Deposition testimony regarding availability of "many references" to an engineer regarding speaker technology).

We also agree with Petitioner and find that "the properties, characteristics, and use of audio transducers (the transducer types disclosed in Rosener) were all well-known by the Critical Date." Reply 10 (citing Ex. 2037, 39:6–17, 38:3–9; Ex. 1025, 182:13–194:4 (Mr. McAlexander deposition testimony that different speakers have different transducers and different applications)). We find that materials for flexible electrical connectors were also well-known by the Critical Date. *See* Reply 12 (citing Ex. 1025, 199:15–201:4 (the '982 patent disclosure "is sufficient to enable a person of ordinary skill in the art to make a set of headphones as claimed in the patent")). Dr. Cooperstock cites to prior art on flexible wiring circuit

boards. Ex. 1024 ¶ 22 (identifying Exs. 1027[13], 1028[14], and 1029[15] as prior art references disclosing exemplary materials). For example, Exhibit 1027 discloses "[a] flexible wiring board." Ex. 1027, Abs. We find that if a person of ordinary skill in the art could make the invention described and claimed in the '982 patent, the combination would likewise be made based on the same level of disclosure in Rosener. *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994).

In sum, Patent Owner's argument is that if the expert cannot succeed in making the combination then neither can the person of ordinary skill in the art.

> The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.

In re Keller, 642 F.2d at 425.

The claims do not include limitations regarding design and operability. Our inquiry is what the combined teachings of the references would have suggested to those of ordinary skill in the art who

> would have had at least a Bachelor's Degree in an academic area emphasizing electrical engineering, computer science, or a similar discipline, and at least two years of experience in wireless communications across short distance or local area networks.

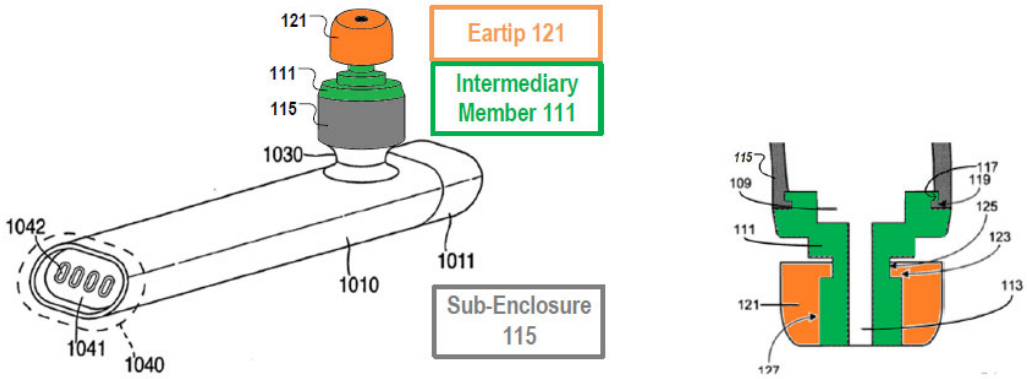
[13] Sera, US Patent No. 5,733,598, issued Mar. 31, 1998 (Ex. 1027).
[14] Lee, US Patent No. 7,281,328 B2, issued Oct. 16, 2007 (Ex. 1028).
[15] Myoung, US Patent No. 7,453,045 B2, issued Nov. 18, 2008 (Ex. 1029).

Section III.A above. We are not persuaded that the design and operational issues raised by Patent Owner would have precluded a person of ordinary skill in the art from understanding the references and any differences between the references and claim 1. Patent Owner does not allege the references teach away from the combination.

Based on the preceding findings, including Petitioner's argument and evidence summarized above, which we adopt, we determine that a person of ordinary skill in the art would have had a reasonable expectation of success in making the asserted combination of Rosener and Hankey.

b. Rosener, Hankey, and Dyer Reasons for Combination

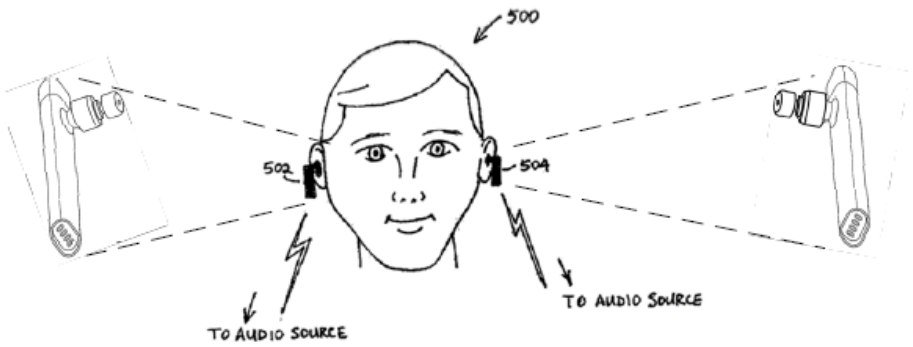
To the extent any structure is argued as necessary by Patent Owner, Petitioner cites to Dyer.[16] Pet. 29 (citing Ex. 1003 ¶ 54). Petitioner alleges motivation to add Dyer based on Dyer and Rosener both describing a "'canal phone' with an element that extends into the user's ear canal." *Id.* at 30 (citing Ex. 1003 ¶ 54). This combination is illustrated by an annotation showing the Rosener, Hankey, and Dyer canalphone compared to Dyer's canalphone, which is reproduced below.



[16] Petitioner adds Dyer as an alternative to the combination of Rosener and Hankey contending "Rosener alone sufficiently shows . . . insertion of a canalphone into a user's ear." Reply 14–15.

Comparison on the left of the canalphone combining Rosener, Hankey, and Dyer and on the right part of Dyer's canalphone.

Pet. 31. Referring to the above annotation, Petitioner explains that a person of ordinary skill in the art "would employ Hankey's techniques of arranging circuitry within small housings to configure the supporting circuitry within sub-enclosure 115 of the Rosener-Hankey-Dyer canalphone." *Id*. (citing Ex. 1005 ¶¶ 202–204, Figs. 20A–C). Petitioner further explains "Dyer's acoustic elements, including its sound delivery tube 113 in intermediary member 111, would deliver sound from the circuitries in sub-enclosure 115 to eartip 121." *Id.* (citing Ex. 1005 ¶¶ 202–204, Figs. 20A–C; Ex. 1003 ¶ 57). An illustration from page 32 of the Petition is reproduced below.



Rosener-Hankey-Dyer system.

Combination of Rosener Figure 5 and annotation of Rosener, Hankey and Dyer (reproduced immediately above).

The illustration above shows a one for one substitution of the Rosener, Hankey, and Dyer canalphone for the earpieces of the Rosener, showing the "Rosener-Hankey-Dyer system." *Id*. at 32.

Patent Owner argues the addition of Dyer's canalphone to the Rosener and Hankey combination "would not stay in a user's ear" and would cause discomfort "because the 'canalphone does not include an adequate securing mechanism, and the 'body portion' thereof forms an extended cantilevered arm between the in-ear portion of the canalphone and the primary housing 1010, which would generate a significant torque at the in-ear portion from the offset weight of the primary housing." PO Resp. 35 (citing Ex. 2039 (Blair Declaration) ¶ 20). Mr. Blair testifies to significant experience designing earphones and headphones. Ex. 2039 ¶ 4.

Relying on the Blair Declaration, Patent Owner argues how each of Rosener, Hankey and Dyer are supported in the ear. PO Resp. 37 (citing Ex. 2039 ¶¶ 10, 12–13). Patent Owner argues Rosener and Hankey are kept in place by the weight of the earbud hanging in the "intratragal notch" of the ear. *Id*. at 36–37 (citing Ex. 2039 ¶¶ 10, 12). Patent Owner argues

Dyer relies on a different method of support where the "earphone 100 is secured within a user's ear by 'a seal between the eartip 121 and the user's ear canal.'" *Id*. at 37 (citing Ex. 2039 ¶ 13). Patent Owner alleges the failure to stay in the user's ear argument would worsen the performance of the earbud and motivation to make the combination would be absent. *Id*. at 39 (citing Ex. 2038 ¶ 62).

Patent Owner criticizes Dr. Cooperstock's testimony, arguing the "entire 'body portion' in Cooperstock's Rosener-Hankey-Dyer canalphone would ***not*** fit in a user's ear because the 'body portion' defines a straight structure that 'does not account for the ear canal's geometry' and 'does not complement the shape of the user's ear canal.'" PO Resp. 37–38 (citing Ex. 1003 ¶ 98 (the body portion of Rosener's earphones "is inserted into an ear of user"); Ex. 2039 ¶ 16 ("Cooperstock's 'body portion' does not account for the ear canal's geometry.")). Patent Owner also asserts that the securing method where the "body portion" of Rosener is inserted into the ear would not be secure. *Id*. at 39 (citing Ex. 2039 ¶ 18). Patent Owner concludes that "performance of the earbud" is worse in the Rosener, Hankey, and Dyer combination and a person of ordinary skill in the art would not be motivated to make such a modification. *Id*. (citing Ex. 2038 ¶¶ 57–62).

Hankey discloses small earpieces capable of communicating with external audio devices wirelessly. Ex. 1005 ¶¶ 93, 103 ("wireless connection"). We find Hankey's small form factor wirelessly connected earpieces resolve the problems identified by Rosener, i.e., "single earpiece monaural devices" or "bulky . . . wired connections" between earpieces, and is a reason to combine the two references. *See* Pet. 24–25 (citing Ex. 1004 ¶¶ 3–10, Figs. 1–4).

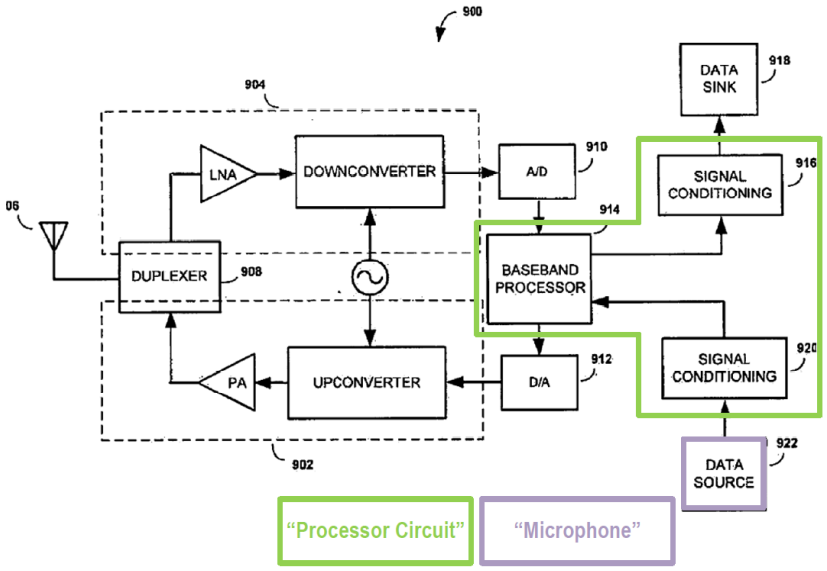
We are not persuaded we should discount the Blair Declaration because he is an employee of Patent Owner and thus is the "testimony of an interested Declarant." *See* Reply 15. Petitioner further argues that Mr. Blair's testimony is conclusory and uncorroborated. *Id*. In support, Petitioner offers testimony from Dr. Cooperstock, although that testimony is also conclusory and does not identify the basis for the testimony. *Id*. at 16 (citing Ex. 1024 ¶¶ 29–31). We give neither expert conclusive weight on the design issues presented.

We are not persuaded by Patent Owner's argument that the Rosener, Hankey, and Dyer combination would not stay in the ear of a user. We find a person of ordinary skill in the art "would have recognized that Rosener's disclosure of a canalphone could be implemented in the Rosener-Hankey combination as advanced in the Petition to provide a superior securing mechanism than an earphone configuration, like that disclosed in Hankey." Reply 18. Patent Owner's response is based on the Blair Declaration, which we determined above is not conclusive on this point. *See* Sur-Reply 13–14. We adopt as our findings Petitioner's argument and evidence summarized above in the Petition and Reply. Pet. 48–49; Reply 11–12. As We find the Rosener, Hankey, and Dyer obviousness claim to be supported by rational underpinnings.

c. Limitation 1.c.iii

Limitation 1.c.iii recites "a microphone connected to the processor circuit and for picking up utterances of a user of the headphones." Petitioner's evidence includes Rosener's teaching that earphones 502 and 504 may include a microphone connected to a processor. Pet. 48 (citing Ex. 1004 ¶ 56; Ex. 1003 ¶¶ 119–120). Petitioner's Annotated Figure 9 is

reproduced below.



Rosener Annotated Figure 9 showing a diagram of an RF transceiver.

Pet. 49. As shown in Annotated Figure 9, Rosener discloses a data source 922 which "provides an input to signal conditioning circuit 920 and baseband processor 914 ("***connected to the processor circuit***"), which process the inputted data prior to providing it to RF transmitter portion 902 for transmission via antenna 906. *Id*. at 48–49 (citing Ex. 1004 ¶ 50). Petitioner contends Rosener's data source 922 is "***a microphone for picking up utterances of a user of the headphones***." *Id*. at 48 (citing Ex. 1003 ¶ 120; Ex. 1004 ¶ 56). The connection between the microphone and processor is illustrated by Petitioner's annotation of Rosener's Figure 9 showing the "Processor Circuit" and "Microphone." *Id.* at 49 (citing Ex. 1004 ¶ 50).

Patent Owner disputes limitation 1.c.iii has been shown. *See* PO Resp. 21–31. Patent Owner argues Rosener does not teach that "both earphones include its own microphone." *Id*. at 21.

> Paragraph 56 of Rosener is set forth below.
>
> According to an embodiment of the invention, either or both the first and second data sinks of the various embodiments may ***include (or be coupled to) a data source*** such as, for example, ***a sensor or a microphone*** to allow a data to be sent back to an external electronic device.

Ex. 1004 ¶ 56 (emphasis added). Patent Owner contends the above quotation from Rosener, upon which Petitioner relies for the limitation, simply provides "examples of generic data sources for the data sinks." PO Resp. 22 (citing Pet. 48 (quoting Ex. 1004 ¶ 56). Patent Owner argues that none of those arrangements conclusively includes a microphone in each earphone. *Id*. Patent Owner further argues paragraph 56 means "in one embodiment, one of the data sinks includes the data source and, in another embodiment, both data sinks are coupled to the data source." *Id*. (citing Ex. 2038 ¶ 64).

For example, one arrangement Patent Owner identifies is "[b]oth earphones being coupled to a data source, which can be the same data source or different data sources." PO Resp. 23. Another arrangement Patent Owner identifies is "[o]ne earphone including a data source, and the other earphone being coupled to a data source." *Id*. Patent Owner disputes that a person of ordinary skill in the art would find it obvious to include a microphone in each of Rosener's earphones. Resp. 32–34. Patent Owner alleges that "[w]ithout the benefit of the '982 Patent's disclosure, a [person of ordinary skill in the art] would not have modified the Rosener-Hankey combination (or the Rosener-Hankey-Dyer combination) to include a microphone in each wireless earphone." *Id*. at 32 (citing Ex. 2038 ¶ 70).

For reasons discussed below, we find both of Patent Owner's examples teach that the "data source" is a microphone, one for each earphone.

We are not persuaded that separate embodiments where Rosener has a single microphone limit its disclosure to a single microphone. Patent Owner relies on Figure 13 as such an instance. PO Resp. 23–25. Patent Owner acknowledges Rosener's paragraph 56 describes "the *particular embodiment* shown in Figure 13, which includes a single microphone and two data sinks." *Id*. at 23–24 (reproducing Figure 13) (emphasis added). Patent Owner makes a similar argument for Figures 6 and 9 of Rosener, contending a microphone is never mentioned in the description of either. *Id*. at 26. We find paragraph 56 broadly discloses the data source may be a microphone in teaching that "either or both the first and second data sinks of the various embodiments may include (or be coupled to) a data source." Ex. 1004 ¶ 56. The first and second data sinks are disclosed as "speakers." *Id*. ¶ 38. As a result, two data sinks may include or be coupled to two speakers. *See* Ex. 1004 ¶ 56 ("either or both . . . data sinks").

Paragraph 56 applies to "various embodiments," which we find includes the separate embodiments shown in Figures 6 and 9. *See* Reply 11 (citing Ex. 1024 ¶¶ 18–19); *see also* Ex. 1003 ¶ 120[17] (citing Ex. 1004 ¶ 56). Beyond asserting the disclosed "data source" is not a microphone in the earphone, Patent Owner does not respond to the separate embodiment issue. Sur-Reply 12 (citing Ex. 1004 ¶¶ 33–34). Paragraphs 33 and 34 of

[17] The relevant Cooperstock Declaration testimony is "[i]n the earphone of FIG. 9, data source 922 can be a microphone (***a microphone for picking up utterances of a user of the headphones***) 'to allow a data to be sent back to an external electronic device.'"

Rosener are not relevant in that they only describe the data source of Figure 6. See Section III.D.4.a above.

Patent Owner cites alleged inconsistencies in Dr. Cooperstock's testimony regarding the "data sources" shown in Rosener's Figures 6 and 9. Sur-Reply 12 (citing Ex. 1003 ¶ 120; Ex. 2038 ¶¶ 65–66; Ex. 1024 ¶ 18). Dr. Cooperstock's original declaration stated that Rosener's "data source" is "a sensor/microphone incorporated within an earphone" and any inconsistency testified to at his deposition "slipped his eyes." Ex. 1024 ¶ 18 (citing Ex. 1003 ¶ 120). A mistake was made and clarified. We do not find the mistake diminishes the Cooperstock Declaration, which is based on the compelling evidence of Rosener's paragraph 56. Ex. 1003 ¶¶ 119–120. We discussed the Cooperstock testimony above in Section III.D.4.a. We find the arguments based on a mistake in the Cooperstock Deposition unpersuasive. *See* Ex. 1024 ¶ 28 (Dr. Cooperstock's testimony explaining his mistake).

Based on the preceding findings, including Petitioner's argument and evidence summarized above, which we adopt, we determine that a person of ordinary skill in the art would have found Rosener and Hankey or Rosener, Hankey, and Dyer teach Limitation 1.c.iii.

d. Claim 1 Remaining Undisputed Limitations

We summarize Petitioner's argument and evidence on the remaining limitations of claim 1 below. Patent Owner does not dispute the remaining limitations. *See* PO Resp. 12–40.

Recitation 1.P, the preamble of claim 1, recites "a system comprising." Although we do not find the preamble to be limiting, Petitioner cites to Rosener as disclosing "a wireless system." Pet. 32 (citing

Ex. 1004 ¶¶ 30, 56; Ex. 1003 ¶ 89. Even if the preamble was limiting, we find that Rosener teaches the recited system.

Limitation 1.a recites "headphones comprising a pair of first and second wireless earphones to be worn simultaneously by a user." Rosener teaches "a wireless headset comprising first and second wireless earphones." Ex. 1004 ¶ 30. The '982 patent states earphones may be "in-ear type headphones," such as disclosed by Rosener. Ex. 1001, 1:50–2:3. Petitioner relies on the preceding as teaching limitation 1.a. Pet. 32–33 (citing Ex. 1004 ¶ 30; Ex. 1003 ¶ 91).

Limitation 1.b recites "wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected." Petitioner cites to Rosener's earphones 502 and 504 in Figure 5 as "physically and electrically" separated when worn. Pet. 33 (quoting Ex. 1004 ¶ 11; Ex. 1003 ¶ 92).

Limitation 1.c recites "wherein each of the first and second earphones comprises." Petitioner points to the fact that a person of ordinary skill would have understood Rosener's earphones each have identical components. Pet. 33–34 (citing Ex. 1004 ¶¶ 30, 46, 49, Figs. 6, 8A–B; Ex. 1003 ¶ 93).

Limitation 1.c.i recites "a body portion that comprises." Petitioner argues Rosener teaches "[e]ach of the first and second wireless earphones 502, 504 comprises a housing containing a speaker, an RF receiver or transceiver and a battery." Pet. 34 (quoting Ex. 1004 ¶ 30). Petitioner contends that Hankey adds teachings regarding the arrangement of electronic components, i.e., "a top portion (***body portion***) of the earpiece,

and a longitudinal member (***elongated portion***) extending away from the top portion." *Id.* (citing Ex. 1005 ¶¶ 94–98, 107–115, 143–144; Ex. 1008,[18] Figs. 1A–B, 20A–C, ¶¶ 89–91; Ex. 1003 ¶ 95).

Limitation 1.c.i.A recites "a wireless communication circuit for receiving and transmitting wireless signals." Petitioner alleges "Rosener discloses that each of earphones 502, 504 includes an RF transceiver circuit (***wireless communication circuit***)." Pet. 36 (citing Ex. 1004 ¶¶ 11, 30). Relying on the Cooperstock Declaration and Figure 9 of Rosener, Petitioner further alleges "[t]he transceiver 900 includes RF transmitter portion 902, RF receiver portion 904, duplexer 908, analog-to-digital (A/D) converter 910, and digital-to-analog converter (D/A) (collectively '***a wireless communication circuit***')." *Id.* at 37 (citing Ex. 1004 ¶¶ 30–36, 49, Fig. 9 (annotated at Pet. 37 to show "Wireless Communication Circuit"); Ex. 1003 ¶¶ 99–100). Petitioner also cites to Hankey as teaching "RF circuitry 1520 is part of a processor 20, which is located inside the earpiece's body portion, a [person of ordinary skill] would have been led to similarly position Rosener's transceiver circuitry (***wireless communication circuit***) in the ***body portion*** of the earphone." *Id.* at 38 (citing Pet. 39, annotated Figs. 1, 15 (Figures 1 and 15 annotated to show "Body portion," "Hankey's Processor 20," "Wireless Communication Circuit," and "Hankey's Processor 20"); Ex. 1008, Fig. 5; Ex. 1003 ¶¶ 92–93, 122).

Limitation 1.c.i.B recites "a processor circuit in communication with the wireless communication circuit." Petitioner relies Rosener's Figure 9 to show this limitation. Pet. 40. Specifically, Petitioner alleges Figure 9

[18] As noted above, the Hankey Provisional cite is for purposes of establishing entitlement to its earlier priority date. See Section II.E above.

includes "components that perform signal processing functions, such as a baseband processor 914 and signal conditioning circuits 916 and 920, and 'additional circuitry and processing capabilities' that 'operate in accordance with different wireless technologies,'" which is a "processor circuit." Pet. 40 (quoting Ex. 1004 ¶¶ 49–51, Fig. 9 (annotated at Pet. 41 to show "Wireless Communication Circuit" and "Processor Circuit"); Ex. 1003 ¶ 104). Petitioner also cites to Hankey's teaching of a processing circuitry located in the body portion of Hankey's earpiece. *Id.* at 41–42 (citing Ex. 1005 ¶¶ 176, 178, Fig. 15; Ex. 1008 ¶¶ 122, 124, Fig. 5; Ex. 1003 ¶ 106–107).

Limitation 1.c.i.C recites "an ear canal portion that is inserted into an ear of the user when worn by the user." As discussed above (Section IV.E), we find this limitation is taught by Rosener. *See* Pet. 44 (citing Ex. 1004 ¶ 30 (earphones may be an earbud "designed to fit into the concha of the pinna of the user's ear; a canalphone, which can be fitted within the ear canal of the user's ear"); Ex. 1003 ¶¶ 34, 109).

Limitation 1.c.i.D recites "at least one acoustic transducer connected to the processor circuit." Petitioner cites Rosener's teaching that each earphone has a speaker in the form of an "acoustic transducer" electrically connected to receivers or transceivers. Pet. 45 (citing Ex. 1004 ¶¶ 2, 30–31, 38, 49 (transceiver connect to other components of the earphone), Fig. 6). Relying on the Cooperstock Declaration, Petitioner alleges that the data sink 918 shown in Figure 9 of Rosener is a speaker, i.e., the claimed acoustic transducer, connected to a processor circuit. *Id.* at 45 (citing Ex. 1004, Fig. 9 (annotated at Pet. 45 showing "Acoustic transducer," "data sink," and "Processor Circuit")).

Petitioner also cites to Hankey as teaching this limitation. Pet. 45–46. Petitioner argues Hankey teaches speakers in the earbud which would have suggest to a person of ordinary skill in the art to "position[ed] Rosener's acoustic transducer in the earphone's body portion as well." *Id.* at 46 (citing Ex. 1005, Fig. 1 (annotated at Pet. 46 showing "Body portion" and "Acoustic transducer"); Ex. 1008 ¶¶ 2, 89; Ex. 1003 ¶ 113).

Limitation 1.c.ii recites "an elongated portion that extends away from the body portion such that the elongated portion extends downwardly when the ear canal portion is inserted in the ear of the user." Petitioner relies largely on Rosener's Figure 5 showing both an "elongated portion" and an "ear canal portion" to teach the limitation. Pet. 47 (citing Ex. 1004, Fig. 5 (annotated at Pet. 47 showing "Elongated portion" and "Body portion"); Ex. 1003 ¶ 115). Hankey is also cited for its teaching of "a ***body portion*** that includes earbud 12, and a longitudinal member (***'an elongated portion'***) ***that extends away from the body portion***." *Id.* (citing Ex. 1003 ¶¶ 116–117).

Limitation 1.c.iv recites "an antenna connected to the wireless communication circuit." Petitioner relies on each of Rosener's earphones including "an ***antenna*** 906 ***connected to the wireless communication circuit*** (i.e., transmitter portion 902, receiver portion 904, duplexer 908, A/D 910, D/A 912)." Pet. 49 (citing Ex. 1004 ¶ 50, Fig. 9 (annotated at Pet. 50 showing "Antenna" and "Wireless communication circuit"); Ex. 1003 ¶ 121).

Limitation 1.c.v recites "a rechargeable power source." Rosener is cited for its disclosure that "each of the earphones includes a battery (***power source***)." Pet. 50 (citing Ex. 1004 ¶ 30). According to Petitioner a

rechargeable battery would have been obvious to a person of ordinary skill because it would "extend the use of the battery and reduce or remove the hassle and cost of periodically replacing non-rechargeable empty batteries." *Id.* (quoting Ex. 1003 ¶ 122). Petitioner also relies on Hankey's teaching "that using rechargeable batteries in headsets was 'traditional[].'" *Id.* (citing Ex. 1005 ¶ 190; Ex. 1008 ¶ 136; Ex. 1003 ¶123).

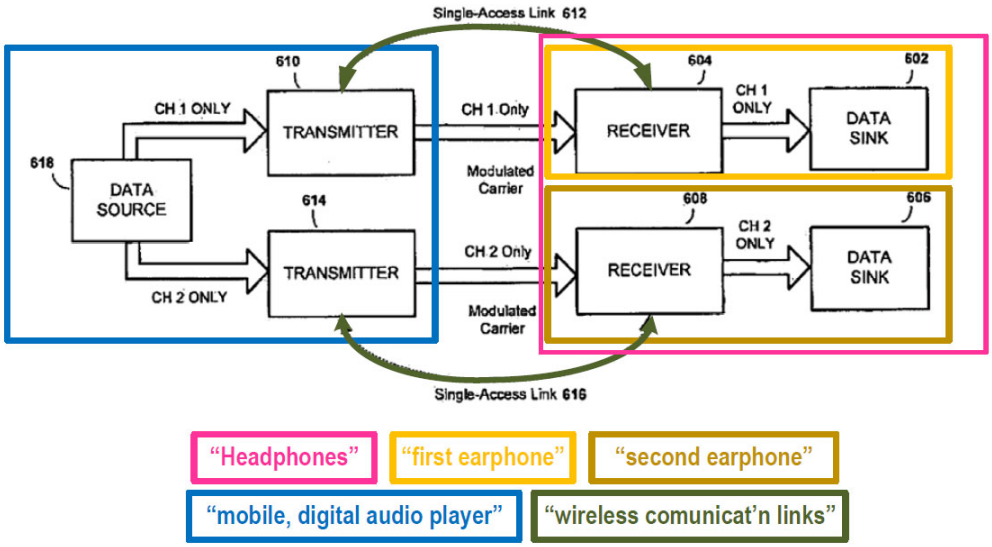
Limitation 1.d recites

> a mobile, digital audio player that stores digital audio content and that comprises a wireless transceiver for transmitting digital audio content to the headphones via Bluetooth wireless communication links, such that each earphone receives and plays audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player.

Petitioner argues Rosener discloses the claimed "mobile, digital audio player" in describing that the earphones communicate with "exemplary external audio devices, including audio players (e.g., MP3 player) that are both digital and mobile." Pet. 51 (citing Ex. 1004 ¶ 2; Ex. 1003 ¶ 124). Petitioner argues a person of ordinary skill in the art "would have understood that a typical MP3 player is mobile and stores digital audio content in the form of, for example, MP3 files and transmits such content to the earphones to be played." *Id.* (citing Ex. 1001, 4:39–43 ("providing MP3 player as an example data source for wirelessly sending and receiving digital audio to and from earphone 10"); Ex. 1003 ¶ 125; *see also* Ex. 1004 ¶ 2 (disclosing mobile, digital audio player to store audio content)).

Petitioner relies on Rosener's teaching that the "wireless communication links can be in the form of Bluetooth communication links." Pet. 52 (citing Ex. 1004 ¶ 35). Petitioner also cites the RF

transmitter and RF receivers used in Rosener's earphones as well as bidirectional transmission over wireless communication links as illustrated in Petitioner's annotation of Rosener's Figure 6 reproduced below.



APPLE-1004, FIG. 6 (annotated).

Rosener's Annotated Figure 6 showing a wireless system.

Pet. 52. As shown in Annotated Figure 6, Petitioner alleges "Rosener also discloses that an external device sends audio content to the earphones through multiple ***wireless communication links*** 612 and 616." Pet. 51–52 (citing Ex. 1004 ¶ 32). Petitioner also asserts the "wireless communication links can be in the form of ***Bluetooth*** communication links." Id. at 52 (citing Ex. 1004 ¶ 35). Petitioner relies on the Cooperstock Declaration for the assertion that a person of ordinary skill would have been motivated to use transmitters/transceivers to "improve processing and communication speed, and to reduce noise." *Id.* at 53 (citing Ex. 1003 ¶ 127). Additional reasons for including a wireless transceiver are also provided by the Cooperstock Declaration and further include that the external devices

disclosed in Rosener "were known to include both wireless transceivers and data storage." *Id*. (citing Ex. 1003 ¶ 127; Ex. 1004 ¶ 30).

If Dyer is necessary for Petitioner to make its showing, which we do not find necessary as summarized above, Petitioner has sufficiently shown a person of ordinary skill would have been motivated to combine Dyer and Rosener because both teach "the same type of earphone – a 'canal phone' with an element that extends into the user's ear canal." Pet. 29–30 (citing Ex. 1003 ¶ 54). This proposed combination of "the Rosener-Hankey canalphone is implemented using Dyer's canalphone elements, including a portion of Dyer's enclosure 115 (which is referred to as the 'sub-enclosure 115' herein) that supports intermediary member 111, along with intermediary member 111 and eartip 121." *Id.* at 30 (citing Ex. 1003 ¶¶ 55–56; Ex. 1006, 2:21–24); *see also* Pet. 31 (annotation at Pet. 31 showing "Eartip 121," "Intermediary Member 111," and "Sub-Enclosure 115"); see also annotation in Section III.D.4.b above (depicting elements 111, 115 and 121).

As summarized above, we adopt Petitioner's argument and evidence regarding claim 1 as our own findings. Petitioner has sufficiently shown recitation 1.P and limitations 1.a, 1.b, 1.c, 1.c.i, 1.c.i.A, 1.c.i.B, 1.c.i.C, 1.c.i.D, 1.c.ii, i.c.iv, 1.c.v and 1.c. are taught by the combination of Rosener and Hankey or Rosener, Hankey, and Dyer.

5. Claims 2 and 18

Claims 2 and 18 depend from claim 1. We have reviewed Petitioner's showing with respect to claims 2 and 18. Pet. 53–55. Patent Owner does not dispute Petitioner's showing with respect to claims 2 and 18. We summarize our findings below.

Claim 2 depends from claim 1. Petitioner shows that the "docking station" recited in limitation 2.a is taught by Hankey's charging device 6600. Pet. 53–54 (citing Ex. 1005 ¶¶ 315–320). Limitation 2.b's recited "power cable for connecting to an external device for charging the at least the first wireless earphone" is sufficiently shown by Hankey's charging device. *Id.* at 54–55 (citing Ex. 1005 ¶ 320; Ex. 1003 ¶¶ 128–130).

Claim 18 depends from claim 1 and recites, in pertinent part, "a buffer for caching the audio content received by the earphone prior to being played by the at least one acoustic transducer of the earphone." Petitioner cites Rosener's teaching that "'the first and second data streams' [are] sent to the first and second earphones 502, 504 by using the data buffer ('***buffer'***) included in each of the earphones." Pet. 55 (citing Ex. 1004 ¶ 39–42).

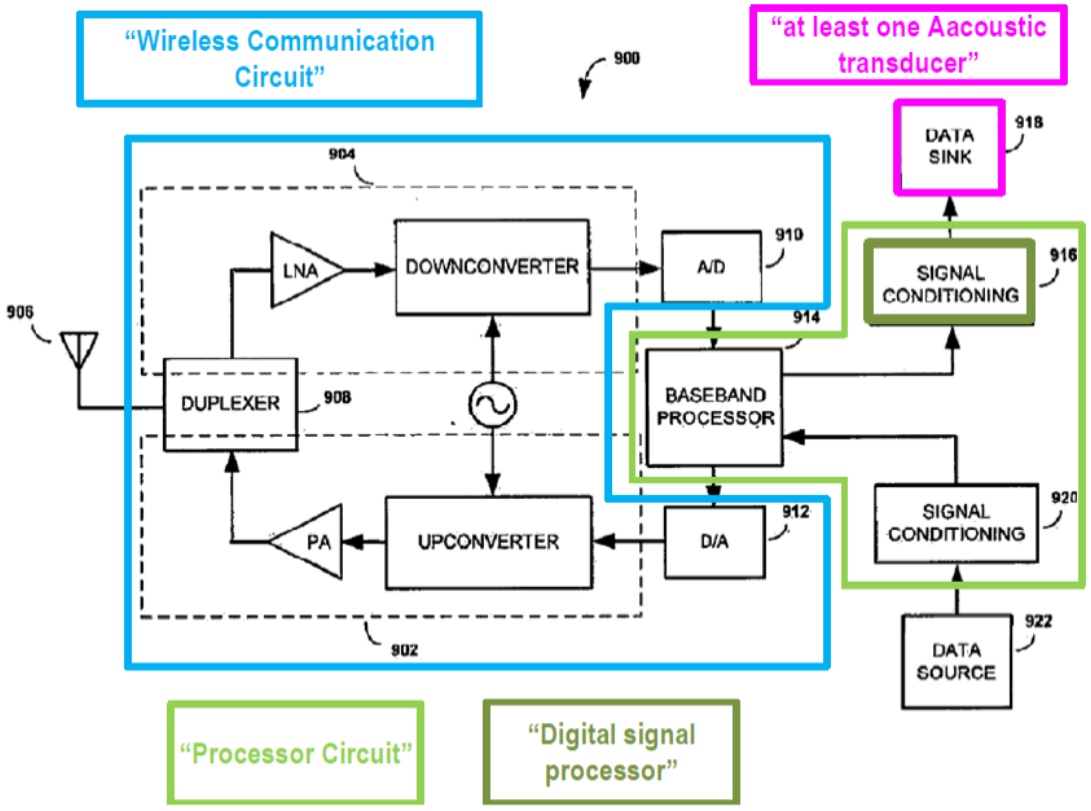
As summarized above, we adopt Petitioner's argument and evidence regarding claims 2 and 18 as our own findings. Pet. 53–55. Petitioner has sufficiently shown that the combination of Rosener and Hankey or Rosener, Hankey, and Dyer teaches claims 2 and 18.

6. Claims 19 and 20

Claim 19 depends from claim 1 and claim 20 depends from claim 19. We have reviewed Petitioner's showing with respect to claims 19 and 20. Pet. 55–58. Claim 19 recites, in pertinent part, that each of the claimed headphones have a "processor circuit" where "the first and second earphones comprises a digital signal processor" for "sound quality enhancement." Rosener is relied on by Petitioner, as it was for limitation 1.c.i.B, for, among other things, its teaching of "signal conditioning circuitry 916 [that] filters and amplifies the audio content to enhance the

sound quality to be played by data sink 918." Pet. 56 (citing Ex. 1004 ¶ 49, *see also* Ex. 1004 ¶¶ 10–11 ("indicating that Rosener's earphones provide 'high-quality stereo sound'")).

Petitioner provides an annotation of Rosener's Figure 9 in support of its arguments. Annotated Figure 9 is reproduced below.



APPLE-1004, FIG. 9 (annotated).

Annotated Figure 9 of Rosener showing an RF transceiver that may be used in place of one or more of the RF transmitters and receivers.

Pet. 57; Ex. 1004 ¶ 24. Specifically, Annotated Figure 9 shows a "digital signal processor," as per claim 19. Ex. 1003 ¶ 132 ("The signal conditioning circuitry ***provides a sound quality enhancement of the audio content*** to be played by data sink 918 (***at least one acoustic transducer of the earphone***).").

Claim 20 depends from claim 19 and recites, in pertinent part, "a baseband processor circuit that is in communication with the wireless communication circuit of the earphone." Petitioner cites to Rosener's teaching "that A/D converter 910 (a component of '***wireless communication circuit***') 'digitizes the signals, and sends the digitized baseband signals to a baseband processor 914.'" Pet. 57 (quoting Ex. 1004 ¶ 49; *see also* Ex. 1003 ¶¶ 133–134).

With reference to Annotated Figure 9, Patent Owner argues "Rosener's signal conditioning circuit converts the digital signal from the baseband processor 914 to an analog signal because the data sink/speaker 918 is driven by an analog signal." PO Resp. 62 (citing Ex. 2039 ¶ 90). Patent Owner argues that the signal conditioning circuit describes a digital-to-analog converter (DAC) and not a digital signal processor. *Id*. at 62–63 (citing Ex. 2039 ¶¶ 35, 91; Ex. 1004 ¶ 49). Patent Owner contends "[t]he 'P' in DSP stands for processor." *Id*. at 63 (citing Ex. 2038 ¶ 93). According to Patent Owner, the difference is important because neither "Rosener's baseband processor nor signal conditioning circuit . . . is a processor that performs signal processing operations, including providing a noise quality enhancement." *Id.* (citing Ex. 2038 ¶93). Patent Owner then asserts that:

> claim 19 recites that the DSP "provides a sound quality enhancement . . . ." [Ex. 1001, 20:29–30]. The '982 Patent lists several sound quality enhancements that could be performed by the DSP, such as "noise cancellation and sound equalization." APPLE-1001, 7:41. A person of ordinary skill in the art would understand that these are sound quality enhancements performed by a DSP, because that is what DSPs do in speakers – improve audio signal prior to delivery to a speaker. [citing Ex. 2038 ¶ 96]. A [person of ordinary skill in the art] would also understand that

> the DSP does not "drive" the speaker because it does not control the voltage and current of the drive signal; i.e., a DSP circuit that improves the signal quality does not convert that digital signal to analog, like a DAC, in order to drive a speaker element. *Id*.

Id. at 64.

Petitioner responds that although Rosener's signal conditioning circuit 916 is a digital-to-analog converter it also performs "signal processing functions." Reply 26 (citing PO Resp., 61–62 (agreeing that signal processing functions occur)); *see also id*. at 29–30 (similarly arguing the signal condition circuit performs the functions alleged to be performed by the DSP). According to Petitioner, this argument is supported by Rosener's disclosure of "signal processing functions." *Id*. (citing Ex. 1004 ¶¶44, 47, 50). Petitioner also argues a person of ordinary skill in the art "would have understood that signal conditioning circuit 916 includes a DSP that processes the digital signal before converting the signal to analog." *Id*. (citing Ex. 1025, 160:2–161:4 (Mr. McAlexander testifying filtering of a signal occurs before and after digital-to-analog conversion); Ex. 1004 ¶ 61).

Petitioner also argues Patent Owner construes digital signal processor to distinguish it from a digital-to-analog converter. Reply 28–29. In sum, Petitioner argues the DSP should be interpreted on its plain meaning. *Id*. at 28. Patent Owner does not propose a construction beyond arguing that a digital-to-analog converter is not a digital signal processor and a person of ordinary skill in the art "would not understand that Rosener's signal conditioning circuit 916 is a digital signal processor as recited in claim 19." *See*, *e.g*., PO Resp. 61 (citing Ex. 2038 ¶ 90). Petitioner argues that Patent Owner's contention that a DSP is "embodied as a single chip (i.e., integrated circuit)" is also improperly narrow. Reply 29 (citing PO Resp.

64). Patent Owner responds that "amplifiers and filters can be analog." Sur-Reply 20 (Ex. 2047, 10:3–8). Patent Owner argues neither Petitioner nor its expert, Dr. Cooperstock, "[ever] explained why it would have been obvious that the amplification and filtering performed by Rosener's signal conditioning circuit would have been digital." *Id*. Patent Owner also argues the examples cited by Petitioner in paragraphs 44, 47, 49, and 50 of Rosener are "are converters, either digital-to-analog or analog-to-digital." *Id*. at 21.

We find Patent Owner's response is persuasive as the cites from Rosener, paragraphs 44, 47, and 50, all involve conversions between analog and digital signals. Sur-Reply 21. It is not disputed that "sound quality enhancement" is being performed by the signal conditioning circuitry of Rosener on analog signals. Figure 9 unannotated clearly shows analog to digital and digital to analog signals processed by a baseband "processor." We are not persuaded that digital-to-analog conversion or analog-to-digital processing would be understood by a person of ordinary skill in the art to be digital processing as performed by a DSP. For example, Petitioner does not show that analog signals of the RF transceiver of Figure 9 are the same as those processed by a "digital signal processor."

As summarized above, we adopt Patent Owner's argument and evidence regarding claim 19. Petitioner has not sufficiently shown that the combination of Rosener and Hankey teaches claim 19 and its dependent claim 20. We need not rely on the Rosener, Hankey, and Dyer combination.

7. Conclusion

We find that the prior art teaches each limitation of claims 1, 2, and 18–20 and that a skilled artisan would have had reason to combine the teachings of Rosner, Hankey, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness are not persuasive. Petitioner has not shown by a preponderance of the evidence that claim 19 and its dependent claim 20 would have been obvious over Rosener and Hankey or over Rosener, Hankey, and Dyer.

E. Obviousness of Claims 3–5 over Rosener, Hankey, and Haupt or Rosener, Hankey, Dyer, and Haupt

Petitioner alleges claims 3–5 would have been obvious over Rosener, Hankey, and Haupt or over Rosener, Hankey, Dyer, and Haupt. Pet. 1, 58–66. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶¶ 135–154.

1. Rosener (Ex. 1004)

Rosener was described in Section III.D.1 above.

2. Hankey (Ex. 1005)

Hankey was described in Section III.D.2 above.

3. Dyer (Ex. 1006)

Dyer was described in Section III.D.3 above.

4. Haupt (Ex. 1020)

Haupt describes "WLAN headphones" to which data (e.g., audio data) can be wirelessly transmitted from a server through an access point. Ex. 1020[19], 2–3. When the headphone is within transmission range of a

[19] Citations are to the native page numbering.

WLAN access point, a connection is made to the server, which permits the headphone to wirelessly receive data from the server. *Id.* at 2.

A private server PS a private sector "connected by a hardwire . . . to an access point APP." Ex. 1020, 6. APP "has a WLAN interface, and communicates wirelessly with a playback device WG located within the transmission range of the access point APP." *Id*. There is also a "public server OS in the public sector" connected wirelessly to the internet. *Id*. "Communication between the playback device WG in the transmission range of the public access point APO and a public or private server OS, PS, takes place wirelessly until reaching the public access point APO, and then takes place via the internet to reach the public server OS or the private server PS." *Id*. at 7.

Haupt also discloses an audio forwarding mode in which a headphone "perform[s] as a local server, providing . . . stored audio files to other playback devices." Ex. 1020, 10. The headphone "can therefore receive data wirelessly from an access point, and then send this data to another playback device." *Id*.

5. Claims 3–5

Claims 3 and 4 depend directly from claim 1 while claim 5 depends from claim 4. We have reviewed Petitioner's showing with respect to claims 3–5. Pet. 58–66. As summarized below, Petitioner has sufficiently shown all the limitations of claims 3–5. Patent Owner does not dispute the showing made on claim 3 or claim 5 beyond the arguments on the claim from which each depends. *See* PO Resp. 46–52 (disputing claim 4).

Claim 3 depends from claim 1 and recites, in pertinent part,

> in a *first operational mode*, the pair of first and second earphones play audio content stored on the mobile, digital audio player and

> transmitted to the first and second earphones from the mobile, digital audio player via the Bluetooth wireless communication links; and in a *second operational mode*, the pair of first and second earphones play audio content streamed from a remote network server." (emphases added).

Petitioner relies on Rosener to teach the "first operational mode," as discussed in above in Section III.D.4.d for limitation 1.d. Pet. 61. Petitioner cites to Haupt's disclosure of "headphones that can receive data from ***a remote network server*** through WLAN communications" for the "second operational mode." *Id.* (citing Ex. 1020, 7–8). Petitioner adds, among other evidence and argument, that "[i]t would have been obvious to a [person of ordinary skill in the art] to incorporate Haupt's techniques and its Bluetooth/WLAN multicommunication-interfaces in Rosener's earphones." *Id.* (citing Ex. 1003 ¶ 135). Petitioner argues the combination "would enable Rosener's earphones to both receive audio from Rosener's disclosed external devices via Bluetooth (in a first operational mode) and audio from Haupt's network server via WLAN communications (in a second operational mode)." *Id.* (citing Ex. 1003 ¶ 135).

> Claim 4 depends from claim 1 and recites, in pertinent part
>
> the processor circuit of the first earphone is for, *upon activation of a user control of the headphones, initiating transmission of a request to a remote network server* that is remote from the mobile, digital audio player and *in communication with* the mobile, digital audio player via a data communication network.

Ex. 1001, 18:56–62 (emphases added). Petitioner cites to Haupt's disclosure of "wireless headphones [with] control buttons ('user control') used to initiate connection to a server." Pet. 65 (citing Ex. 1020, 11–12,

22). Petitioner also alleges "user control" as claimed would have been obvious based on Haupt. *Id.* (citing Ex. 1020, 2–4, 9–13, 22; Ex. 1003 ¶ 150).

Claim 5 depends from claim 4 and recites, in pertinent part, "the processor circuit of the first earphone is further for receiving a response to the request." Petitioner quotes from Haupt as teaching "in order to upload [stored music] to the wireless headphones for playback," "[a] playlist [for stored music] can be compiled on the network server" and then "sent from there to the headphones." Pet. 66 (quoting Ex. 1020, 22). Petitioner also asserts claim 5 would have been obvious to a person of ordinary skill in the art based in part on Haupt's teachings of processing received data from a server. *Id.* (citing Ex. 1003 ¶ 154).

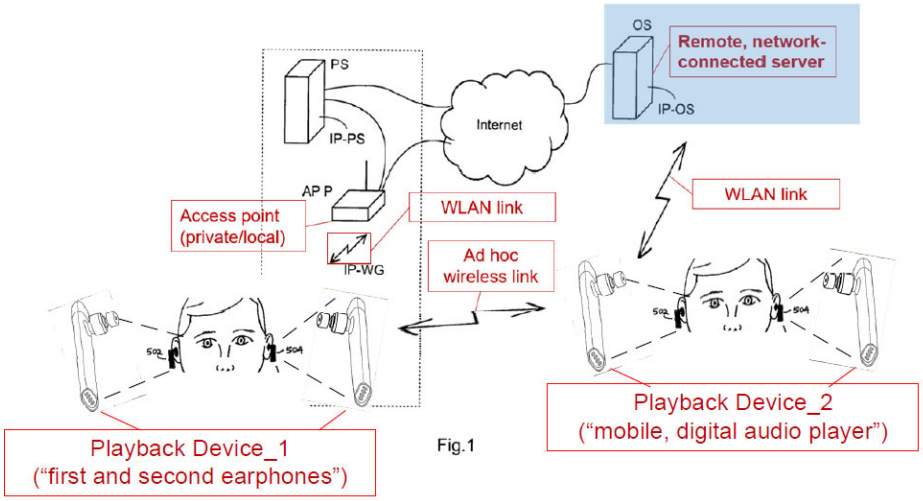
Patent Owner disputes that claim 4 and its dependent claim 5 have been shown to be unpatentable. PO Resp. 46–52. Patent Owner summarizes Petitioner's showing as follows:

> Petitioner's proposed combination is limited, at best, to a system in which the headphones communicate wirelessly with a remote network server (Haupt's PS or OP) to receive digital audio content from that server (per Haupt) and, separately, connects to a mobile DAP (e.g., Rosener's external data source) that provides the digital audio content to the headphones.

Id. at 48. Patent Owner argues that Petitioner "does not explain why Haupt's remote server to which the request is transmitted in Petitioner's proposed Rosener-Hankey-Haupt (-Dyer) combination would be in communication with Rosener's external data source 618." *Id*.

Petitioner argues claim 4 was shown in "the master/slave configuration discussed in the Petition, the headphone recited in claim 4 is mapped to a slave headphone (or Playback Device_1), and the mobile DAP

recited in claim 4 is mapped to a master headphone (or Playback Device_2)." Reply 19 (citing Pet. 61–66). An annotation based on Haupt's figures[20] (Ex. 1003 ¶ 141) is reproduced below.



Annotated schematic showing audio forwarding mode in which one pair of the canalphones (the "master") acts as a mobile, digital audio player for another pair of canalphones.

Pet. 63; Reply 20. Petitioner argues that a person of ordinary skill in the art "would have understood that the master earphone in Haupt is another example of Rosener's data source 618 (which was mapped to mobile DAP in claim 1) because the master earphone is a device that sends audio to another earphone, which is the same function that Rosener lists for data source 618." Reply 20 (citing Ex. 1024 ¶ 43).

Patent Owner responds that the "slave" in Petitioner's master/slave theory

[20] We take notice that the figure also includes the annotated drawing at page 32 of the Petition of the "Rosener-Hankey-Dyer system," illustrating "Playback Device_1" and "Playback Device_2." The annotation is reproduced in Section III.D.4.b above.

> cannot initiate transmission of a request to the server that is connected to the "master." At a minimum, Petitioner never explained how the slave initiates transmission of a request to the server that is communication with the master in light of Haupt's teaching that the server interrupts communications from devices with IP addresses other than the master device.

Sur-Reply 16.

Patent Owner does not cite any evidentiary support for its interruption of communication argument based on Haupt. Haupt explains that "[i]f the IP address of the data receiver is not the IP address IP-WG for the playback device, the respective data transfer *can be interrupted*." Ex. 1020, 7 (emphasis added). If Patent Owner is arguing this excerpt for support, it states that "data transfer" is not necessarily interrupted.

Patent Owner does not respond to the combination of Rosener and Haupt, on which Petitioner relies. Specifically, Petitioner alleges a person of ordinary skill in the art "would have understood that the master earphone in Haupt is another example of Rosener's data source 618." Reply 20. Patent Owner does not dispute, and we find, Haupt and Rosener teach the two operational modes of claim 3. See above Section III.E.5 (re: claim 3). We also find that Haupt discloses "wireless headphones . . . control buttons ('user control') used to initiate connection to a server." Pet. 65 (citing Ex. 1020, 11–12, 22) (emphasis omitted).

Petitioner argues a person of ordinary skill in the art would have had reason to combine Haupt with Rosener and Hankey. One reason is that Rosener's earphones would have been improved by accessing WLAN technology in order for communication over the

Internet to occur. Pet. 59–60 (citing Ex. 1003 ¶¶ 65–66). Patent Owner does dispute the rationale for the combination, citing an institution decision in another *inter partes* review between the same parties on a different patent. PO Resp. 49–52 (citing *Apple Inc. v. Koss Corp.*, IPR2021-00546, Paper 10 at 6–7, 14–16 (PTAB Sept. 7, 2021) ("'546 IPR")).

We agree with Petitioner that the grounds under consideration here are not the same as in the '546 IPR. Reply 21. The '546 IPR challenge included the reference to Seshardri, alleged prior art which is not at issue here. *See* PO Resp. 50. Patent Owner does not explain how Seshardri is relevant here and the argument is not persuasive.

As summarized above, we adopt Petitioner's argument and evidence regarding claims 3–5 as our own findings. Petitioner has sufficiently shown that the combination of Rosener, Hankey, and Haupt or Rosener, Hankey, Haupt, and Dyer teaches claims 3–5.

6. Conclusion

We find that the prior art teaches each limitation of claims 3–5 and that a skilled artisan would have combined the teachings of Rosner, Hankey, Haupt, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness are not persuasive. After considering the complete record, we conclude that Petitioner has shown by a preponderance of the evidence that claims 3–5 would have been obvious over Rosener, Hankey, and Haupt or over Rosener, Hankey, Dyer, and Haupt.

F. Obviousness of Claim 14 over Rosener, Hankey, and Price or Rosener, Hankey, Dyer, and Price

Petitioner alleges claim 14 would have been obvious over Rosener, Hankey, and Price or over Rosener, Hankey, Dyer, and Price. Pet. 1, 67–

72. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶¶ 155–157. Patent Owner disputes the showing on claim 14. PO Resp. 52–57.

1. Rosener (Ex. 1004)

Rosener was described in Section III.D.1 above.

2. Hankey (Ex. 1005)

Hankey was described in Section III.D.2 above.

3. Dyer (Ex. 1006)

Dyer was described in Section III.D.3 above.

4. Price (Ex. 1009)

Price describes a "software updating system" for updating software on electronic devices. Ex. 1009 ¶¶ 37, 7–11. The system includes a "coordinating computer" (or "proxy server"), which is an intermediary device between (i) a server providing software update codes and (ii) one or more devices to be updated using the software update codes. *Id.* ¶¶ 7, 25. The coordinating computer can provide software update codes to each device "without requiring user intervention." *Id.* ¶ 35. One example of software content is "firmware typically stored in an EEPROM." *Id.* ¶ 29.

Figure 1 of Price is reproduced below.

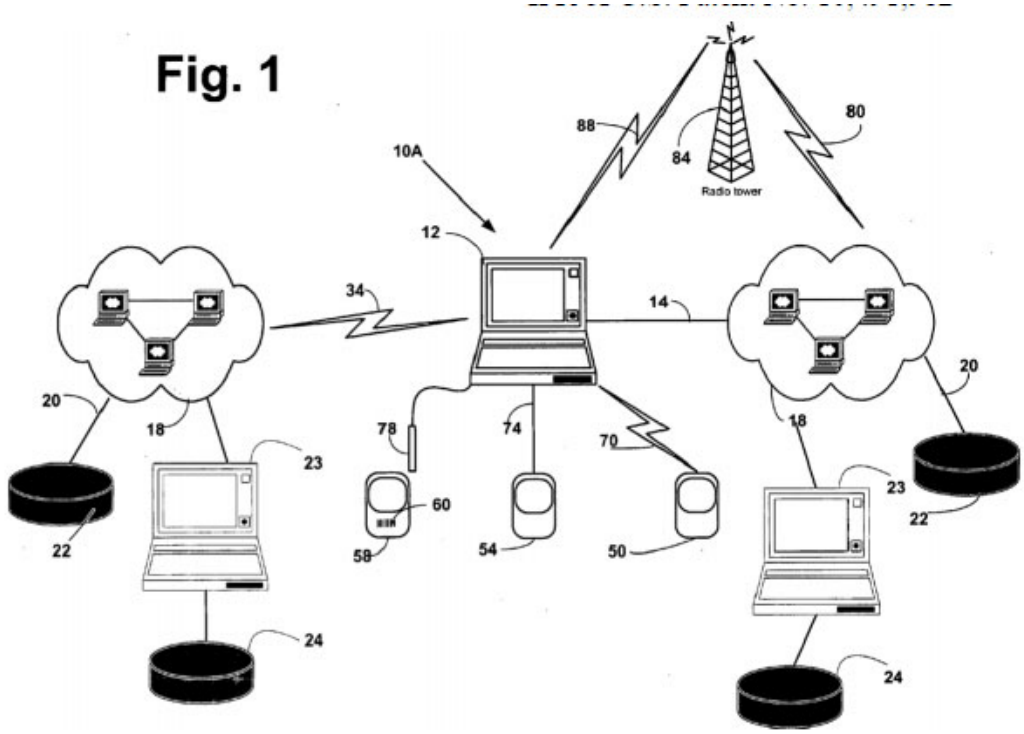


Figure 1 is a schematic of a particular embodiment of Price's system.

Ex. 1009 ¶ 13. Figure 1 illustrates a system 10A, with a coordinating computer 12 is in communication 14 with a network 18 in communication 20 with a network data store 22. *Id.* ¶ 37. Server 23 provides software update codes to computer 12 through network 18 using wired communication 14 or wireless communication 34. *Id.* ¶ 38. Computer 12 then processes the software update codes and delivers them to devices 50, 54, 58. *Id.* ¶ 39. Once the software update codes are delivered, software in devices 50, 54, 58 are updated. *Id.*

5. Claim 14

Claim 14 depends from claim 1 and recites "wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server."

Petitioner alleges that Price describes that "'[c]omplex digital devices' requiring 'microprocessors,' and 'firmware, an operating system, or other device-specific software' benefit from receiving software updates by improving reliability, functionality, or compatibility." Pet. 68–69 (quoting Ex. 1009 ¶¶ 5, 11). According to Petitioner, Rosener's headphones 502, 504 could be configured to "'***receive***' software update code for firmware updates transmitted from a remote server, via a coordinating computer (e.g., computer 12)." *Id.* at 69–71 (regarding Rosener headphones). Further, Petitioner alleges a person of ordinary skill in the art "would have understood that a firmware upgrade is one example of a firmware update and, therefore, would have found it obvious to configure earphones 502, 504 to receive software update code representing '***firmware upgrades***' in order to upgrade the capabilities of earphones 502, 504." *Id.* at 71 (citing Ex. 1003 ¶ 155).

Petitioner argues the combination of Price with Rosener "would have involved applying conventional techniques within the [person of ordinary skill in the art's] skill level." Pet. 70. Petitioner provides, as an example, Price's description "that device 50 can receive software update code from computer 12 using wireless channel communication 70, which coincides with the one or more wireless links Rosener's earphones 502, 504 already have with an external data device." *Id.* (citing Ex. 1003 ¶ 72; Ex. 1004 ¶ 30; Ex. 1009 ¶ 39).

Patent Owner alleges that "updating a device's firmware requires that the device be sufficiently powered throughout the firmware upgrade process." PO Resp. 53 (citing Ex. 2038 ¶ 70). Patent Owner acknowledges Hankey's earpiece downloads updates but requires power from an external

power supply. *Id*. (citing Ex. 1005 ¶¶ 182–188). According to Patent Owner "Hankey does not disclose using the earpiece's battery to power the earpiece during a firmware upgrade and Rosener does not disclose a way to connect to an external power supply." *Id*. at 53–54. Patent Owner argues Rosener's earphones would have to be modified to include a power source, i.e., a battery, which would be beyond the level of ordinary skill determined previously. *Id*. at 54. Patent Owner notes that none of the other references in this challenge address this power issue, resulting in no expectation of success from the combination. *Id*. at 55–56.

We agree with Petitioner that the argument Patent Owner makes is not supported by the evidence. Reply 24. Furthermore, as Petitioner argues, a person of ordinary skill in the art "would have understood how to implement configuration options that would have addressed any power consumption issues associated with firmware upgrades." *Id*. (citing Ex. 1024 ¶¶ 49–50).

Patent Owner's argument is predicated on bodily incorporating a battery into Hankey or Rosener's earpieces. As already stated, how to put together a device based on the combined references is not required in order to find a claim obvious. *In re Keller*, 642 F.2d at 425. In addition, Patent Owner did not dispute that Rosener and Hankey taught a "rechargeable power source," limitation 1.c.v. *See* Section III.D.4.d (limitation 1.c.v above). Claim 14 itself does not recite a power source. All that is required by claim 14 is that "the headphones are configured to receive firmware upgrades pushed from a remote network server." How the firmware is "pushed" is left to the understanding of a person of ordinary skill in the art and is not directly recited.

Patent Owner attempts to distinguish "charging" from "powering during use." Sur-Reply 16–17 (emphasis omitted). Other than timing, we are not persuaded there is a difference and Patent Owner does not support its argument with evidence. Patent Owner's responses to Petitioner's other arguments, "conditional or incremental firmware upgrades" and improper incorporation "system-on-chip (SOC)" from the written disclosure into the claims of the '982 patent, do not persuade us that our determination is erroneous. *See* Sur-Reply 17–18.

We find that the prior art teaches each limitation of claim 14 and that a skilled artisan would have combined the teachings of Rosner, Hankey, Price, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness are not persuasive. After considering the complete record, we conclude that Petitioner has shown by a preponderance of the evidence that claim 14 would have been obvious over Rosener, Hankey, and Price or over Rosener, Hankey, Dyer, and Price.

G. Obviousness of Claim 15 over Rosener, Hankey, and Paulson or Rosener, Hankey, Dyer, and Paulson

Petitioner alleges claim 15 would have been obvious over Rosener, Hankey, and Paulson or over Rosener, Hankey, Dyer, and Paulson. Pet. 1, 72–75. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶¶ 158–159. Patent Owner disputes that claim 15 would have been obvious. PO Resp. 57–60.

1. Rosener (Ex. 1004)

Rosener was described in Section III.D.1 above.

2. Hankey (Ex. 1005)

Hankey was described in Section III.D.2 above.

3. Dyer (Ex. 1006)

Dyer was described in Section III.D.3 above.

4. Paulson (Ex. 1010)

Paulson describes a "two-way voice communication device" with a "switch supporting a push-to-talk" operation. Ex. 1010, 2:51–67. The device includes "earphone assembly 105" with housing 110 and microphone 130 located at one end of boom 120. *Id.* at 5:1–13, Fig. 1B.

Paulson describes that an "electrical signal from a microphone" (e.g., microphone 130) can be "carried on conductors 343 and 344." Ex. 1010, 6:17–19, Fig. 3. Paulson also describes that "switch 330 may be arranged to provide push-to-talk functionality." *Id.* at 6:43–44. "When activated, switch 330 may stop the electrical signals of microphone 130 from reaching the designated conductors of multi-conductor cable 350, effectively muting microphone 130." *Id.* at 6:30–33.

5. Claim 15

Limitation 15.1 of claim 15, which depends from claim 1, recites "wherein the processor circuit of the first earphone is configured to: process audible utterances by the user picked by the microphone in response to activation of the microphone by the user." Pet. 74. Petitioner contends that Rosener's earphones 502, 504 include "a microphone to collect '***audible utterances by the user***.'" *Id*. (quoting Ex. 1004 ¶ 56). Petitioner argues Paulson's teaching that a switch is "important for users in a noisy environment, to allow [users] to reduce the noise heard by [a] distant party." *Id.* at 73–74 (citing Ex. 1010, 6:33–49; Ex.1003 ¶ 76).

Limitation 15.2 of claim 15 recites "transmit a communication based on the audible utterances via the Bluetooth wireless communication links."

Pet. 75. Petitioner cites Rosener's teaching that "earphones 502, 504 can provide 'two-way communications between a user and an external data device (e.g., a cellular telephone),' e.g., via Bluetooth connections." Pet. 75 (citing Ex. 1004 ¶¶ 11, 35). According to Petitioner, a person of ordinary skill in the art "would have understood that earphones 502, 504 would have been configured to provide two-way communications with an external device using Bluetooth connections ('***Bluetooth wireless communication links***') such that audio generated by a user's voice ('***communication based on the audible utterances***') are transmitted from earphones 502, 504 to the cellular telephone." *Id.* at 75 (citing Ex. 1004 ¶ 50; Ex. 1003 ¶ 159).

Patent Owner argues that Paulsen's earphone is not wireless. PO Resp. 58 (citing Ex. 1010, Fig. 3 (switch 330); Ex. 2038 ¶ 85). Patent Owner argues Petitioner has not shown "how Paulson's pressure-actuated, mechanical switch would be implemented into Rosener's small form factor earphones. Mechanical switches are typically larger in size than solid-state or MEMS (microelectromechanical systems) switches because mechanical switches have (non-micro) moving parts." *Id*. at 59 (citing Ex. 2038 ¶ 87). Again, Patent Owner argues such an implementation would be beyond the level of ordinary skill we have determined for the '982 patent in this proceeding. *Id*. at 59–60 (citing, *inter alia*, Ex. 2038 ¶ 87).

Bodily incorporation is not required in order to meet the test of obviousness. *In re Keller*, 642 F.2d at 425. Petitioner's argument is in accord, arguing, as we also find, Paulson's mechanical button "does not mean that [a person of ordinary skill in the art] would have had to physically incorporate the exact mechanical button from Paulson into Rosener-Hankey earphone." Reply 24–25 (citing Ex. 1024 ¶¶ 53–54).

Petitioner argues a person of ordinary skill in the art "reading Paulson would get the idea of incorporating the push-to-talk button to Hankey's device." Reply 24 (citing Ex. 1024 ¶¶ 53–54). Patent Owner argues that the "button" would provide the idea recited in claim 15 raises a new argument not presented in the Petition. Sur-Reply 19. We disagree. The argument was a response to the argument raised in pages 59 through 60 of Patent Owner's Response. Patent Owner does not respond to the bodily incorporation argument made by Petitioner. We find that bodily incorporation is dispositive of the positions raised by Patent Owner.

6. Conclusion

We find that the prior art teaches each limitation of claim 15 and that a skilled artisan would have combined the teachings of Rosner, Hankey, Paulson, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness are not persuasive. After considering the complete record, we conclude that Petitioner has shown by a preponderance of the evidence that claim 15 would have been obvious over Rosener, Hankey, and Paulson or over Rosener, Hankey, Dyer, and Paulson.

H. Obviousness of Claims 16 and 17 over Rosener, Hankey, and Huddart or Rosener, Hankey, Dyer, and Huddart

Petitioner alleges claims 16 and 17 would have been obvious over Rosener, Hankey, and Huddart or over Rosener, Hankey, Dyer, and Huddart. Pet. 1, 76–82. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶ 160. Patent Owner does not dispute Petitioner's showing regarding claims 16 and 17.

1. Rosener (Ex. 1004)

Rosener was described in Section III.D.1 above.

2. Hankey (Ex. 1005)

Hankey was described in Section III.D.2 above.

3. Dyer (Ex. 1006)

Dyer was described in Section III.D.3 above.

4. Huddart (Ex. 1007)

Huddart describes a wireless stereo system that includes a headset component and a wireless earbud component. Ex. 1007, 2:13–15. Headset 4 communicates with electronic device 2 over a wireless communication link 12. *Id.* at 2:52–3:6. During a "stereo listening operation," wireless earbud 6 is used in conjunction with headset 4 through wireless communication link 18. *Id.* at 3:7–18. In this mode, headset 4 and earbud 6 can be used in conjunction for stereo listening from "a cellular telephone 100, digital music player 106," among other electronic devices. *Id.* at 7:62–8:8.

Huddart describes embodiments in which the wireless stereo system includes a "charger/carrier" with "a small plastic storage case for storing headset 4 and wireless earbud 6 for protection and charging." Ex. 1007, 8:25–27. The charger/carrier includes "a battery and charger circuit for charging both the headset battery and wireless earbud battery when inserted into the . . . charger/carrier." *Id.* at 8:27–31. The charger/carrier can be pocket size, providing "a convenient mechanism" to charge the batteries frequently. *Id*. at 8:31–33. Since the earbud can have "a relatively small[] capacity battery due to its limited size," the pocket charger/carrier provides the convenience of frequent charging of the earbud "in the absence of a primary charger." *Id*. at 8:31–34. The pocket charger/carrier is portable. *Id*. "The primary charger may be a cable or docking facility connecting the

pocket charger/carrier to a wall outlet or [a] primary batter[y]" to allow a storage case battery on the pocket charger/carrier to be charged. *Id*. at 8:52–57.

The charger/carrier is capable of charging the earbud's and the headset's batteries wirelessly. Ex. 1007, 8:37–40. As a result, "the earbud advantageously does not require charging contacts on its small exterior surface when charging is performed with inductive charging." *Id.*

5. Claims 16 and 17

Claim 16 depends from claim 1 and recites "wherein the rechargeable power source comprises a wirelessly chargeable circuit." Huddart teaches a wireless battery and enabling circuitry. Ex. 1007, 8:35–50. Petitioner relies on this teaching to show claim 16. Pet. 80 (citing Ex. 1007, 8:35–50; Ex. 1003 ¶ 160).

Claim 17 depends from claim 1 and recites "wherein the rechargeable power source comprises a passive, wireless rechargeable power source." Petitioner argues "passive" is described in a prior art United States patent and is "not inventive." Pet. 80–81 (citing Ex. 1001, 7:7–9 (referencing US Patent No. 7,027,311 toVanderelli (Ex. 1012); *see also* Section III.I.5 (describing Vanderelli).

According to Petitioner, a person of ordinary skill in the art would have looked to Huddart "to reduce the number of components needed on the surface area of small compact Rosener-Hankey/Rosener-Hankey-Dyer earphones," thus "eliminating the charging contacts on the surface of the earphones." Pet. 78 (citing Ex. 1003 ¶¶ 81–82; Ex. 1007, 8:38–45).

We find that the prior art teaches each limitation of claims 16 and 17 and that a skilled artisan would have combined the teachings of Rosner,

Hankey, Huddart, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness is not persuasive. After considering the complete record, we conclude that Petitioner has shown by a preponderance of the evidence that claims 16 and 17 would have been obvious over Rosener, Hankey, and Huddart or over Rosener, Hankey, Dyer, and Huddart.

I. Obviousness of Claim 17 over Rosener, Hankey, Huddart, and Vanderelli or Rosener, Hankey, Dyer, Huddart, and Vanderelli

Petitioner alleges claim 17 would have been obvious over Rosener, Hankey, Huddart, and Vanderelli or over Rosener, Hankey, Dyer, Huddart, and Vanderelli. Pet. 1, 82–85. Petitioner also relies on the Cooperstock Declaration. Ex. 1003 ¶¶ 166–167. Patent Owner does not dispute Petitioner's showing regarding claim 17.

1. Rosener (Ex. 1004)

Rosener was described in Section III.D.1 above.

2. Hankey (Ex. 1005)

Hankey was described in Section III.D.2 above.

3. Dyer (Ex. 1006)

Dyer was described in Section III.D.3 above.

4. Huddart (Ex. 1007)

Huddart was described in Section III.H.4 above.

5. Vanderelli (Ex. 1012)

Vanderelli describes circuitry for wireless charging that converts radiation energy obtained from "a range of RF radiation" into direct current (DC) output. Ex. 1012, 1:40–45, Fig. 1.

The circuitry includes antenna 12 for receiving RF radiation and inductor 18 for converting RF radiation into a storable form. Ex. 1012, 2:1–58. To allow energy to be obtained from a range of frequencies,

inductor 18 is divided into taps 20, which are calculated to match "the inductor's impedance to [the] desired RF range." *Id.* Diodes 26 direct converted energy to capacitors C1–Cx, where the energy is stored as DC voltage. *Id.* "The sum of the voltages available from C1–Cx is stored in any storage device 28 such as a capacitor [and is] made available for immediate use." *Id.* at 4:9–17

6. Claim 17

Claim 17 is described above in Section III.H. With respect to Vanderelli, Petitioner argues it would be added to the combination "to thereby enjoy advantages of obtaining energy from a range of RF frequencies." Pet. 85. "[T]he resulting system would have provided earphones 502, 504, each with a rechargeable power source that may comprise capacitors passively charged with RF radiation ('***passive, wireless rechargeable power source***')." *Id.* (citing Ex. 1003 ¶ 167).

We find that the prior art teaches each limitation of claim 17 and that a skilled artisan would have combined the teachings of Rosner, Hankey, Huddart, Vanderelli, and Dyer. As explained below, Patent Owner's objective indicia of nonobviousness are not persuasive. After considering the complete record, we conclude that Petitioner has shown by a preponderance of the evidence that claim 17 would have been obvious over Rosener, Hankey, Huddart, and Vanderelli or over Rosener, Hankey, Dyer, Huddart, and Vanderelli.

J. Objective Indicia of Nonobviousness

Patent Owner argues that the sales of Petitioner's AirPods and AirPods Pro products (collectively "AirPods Products") have achieved significant sales and are thus evidence of commercial success that confirms

that the '982 patent claim 1 would not have been obvious. PO Resp. 41 (citing Ex. 2044[21], 15). Patent Owner also alleges that dependent claims 4, 5, 14, 15, 19, and 20 are embodied by commercially successful products based on "record evidence" showing that the AirPods Products "when used with an iPhone as the mobile DAP, possess the elements of these claims." *Id*. at 65 (citing Ex. 1014[22], 1018–1019,1033–1035, 1038–1039, 1056–1057, 1071–1073, 1076–1077).

Notwithstanding what the teachings of the prior art would have suggested to one skilled in the art, objective evidence of non-obviousness (so called "secondary considerations") may lead to a conclusion that the challenged claims would not have been obvious. *In re Piasecki*, 745 F.2d 1468, 1471–72 (Fed. Cir. 1984). Objective evidence of non-obviousness "may often be the most probative and cogent evidence in the record" and "may often establish that an invention appearing to have been obvious in light of the prior art was not." *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1349 (Fed. Cir. 2012) (quoting *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983)). Objective evidence may include long-felt but unsolved need, failure of others, unexpected results, commercial success, copying, licensing, and praise. *See Graham*, 383 U.S. at 17–18; *Leapfrog Enters., Inc. v. Fisher–Price, Inc.*, 485 F.3d 1157, 1162 (Fed. Cir. 2007).

Commercial success is typically shown with evidence of "significant sales in a relevant market." *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d

[21] Available at https://www.businessofapps.com/data/apple-statistics/
[22] District Court Lawsuit, "Plaintiff Koss Corporation's Preliminary Infringement Contentions" (Ex. 1014).

1299, 1312 (Fed. Cir. 2006) (citation omitted). "When a patentee can demonstrate commercial success, usually shown by significant sales in a relevant market, and that the successful product is the invention disclosed and claimed in the patent, it is presumed that the commercial success is due to the patented invention." *J.T. Eaton & Co. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997).

To give substantial weight to objective indicia of nonobviousness such as commercial success, a proponent must establish a nexus between the evidence and the merits of the claimed invention. *ClassCo, Inc. v. Apple, Inc.*, 838 F.3d 1214, 1220 (Fed. Cir. 2016). Nexus is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining non-obviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). "[T]here is no nexus unless the evidence presented is 'reasonably commensurate with the scope of the claims.'" *ClassCo*, 838 F.3d at 1220 (quoting *Rambus Inc. v. Rea*, 731 F.3d 1248, 1257 (Fed. Cir. 2013)). A patentee is entitled to a presumption of nexus "when the patentee shows that the asserted objective evidence is tied to a specific product and that product 'embodies the claimed features, and is coextensive with them.'" *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (quoting *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1072 (Fed. Cir. 2018)). "[T]he patentee retains the burden of proving the degree to which evidence of secondary considerations tied to a product is attributable to a particular claimed invention." *Fox Factory*, 944 F.3d at 1378. The Federal Circuit has held that "if the marketed product embodies the claimed features, and is

coextensive with them, then a nexus is presumed and the burden shifts to the party asserting obviousness to present evidence to rebut the presumed nexus." *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1130 (Fed. Cir. 2000).

"[T]he purpose of the coextensiveness requirement is to ensure that nexus is only presumed when the product tied to the evidence of secondary considerations is the invention disclosed and claimed." *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 33 at 32 (PTAB Jan. 24, 2020) (precedential) (citing *Fox Factory*, 944 F.3d at 1374) (emphasis and internal quotation marks omitted) (alteration in original). "[T]he degree of correspondence between a product and the patent claim falls along a spectrum. At one end of the spectrum lies perfect or near perfect correspondence. At the other end lies no or very little correspondence." *Id.* (alteration in original). Also, "[a] patent claim is not coextensive with a product that includes a 'critical' unclaimed feature that is claimed by a different patent and that materially impacts the product's functionality." *Id.* (citing *Fox Factory*, 944 F.3d at 1375).

"A finding that a presumption of nexus is inappropriate does not end the inquiry into secondary considerations"; rather, "the patent owner is still afforded an opportunity to prove nexus by showing that the evidence of secondary considerations is the 'direct result of the unique characteristics of the claimed invention.'" *Fox Factory*, 994 F.3d at 1374 (quoting *In re Huang*, 100 F.3d 125, 140 (Fed. Cir. 1996)).

"Ultimately, the fact finder must weigh the [objective indicia] evidence presented in the context of whether the claimed invention as a whole would have been obvious to a skilled artisan." *See Lectrosonics*,

Paper 33 at 33 (citing *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1331–32 (Fed. Cir. 2016)).

As evidence of commercial success, Patent Owner relies on public sources to estimate that Petitioner sold: 15 million AirPods in 2017; 35 million AirPods in 2018; 60 million AirPods in 2019; and 114 million AirPods in 2020. PO Resp. 41 (citing Ex. 2044[23], 15). Patent Owner argues that "[a]t $159 USD apiece, that amounts to more than $35 billion in sales in four years. This estimate is exceedingly great because the AirPod[s] Products dominate the market for 'true wireless' stereo headphones." *Id*. at 43 (citing Ex. 2046[24], 1). Patent Owner also alleges the market for wireless headphones is growing, "which is an important component of . . . commercial success.'" *Id*. at 43–44 (citing Ex. 2046, 2; *In re Applied Materials, Inc*., 692 F.3d 1289, 1300 (Fed. Cir. 2012)).

Patent Owner argues that nexus exists between the AirPods Products and claim 1 based on a November 6, 2020, infringement claim chart, comparing the AirPods Products to the '982 patent claims, that it had submitted in the District Court Lawsuit. PO Resp. 44 (citing Ex.1014, 1003–1014 (AirPods Pro), 1041–1052 (AirPods)). Patent Owner also relies on the instructions to "Connect your AirPods and AirPods Pro to your iPhone." *Id.* at 42–44 (citing Ex. 2045[25], 1). Patent Owner does not provide a detailed comparison of the AirPods with the challenged claims in its Response. *Id*. at 44–45. Nevertheless, Petitioner does not contest, in this

[23] *Available at* https://www.businessofapps.com/data/apple-statistics/.
[24] *Available at* https://9to5mac.com/2021/01/27/airpods-dominate-wireless-headphone-market/.
[25] *Available at* https://support.apple.com/en-us/HT207010.

proceeding at least, that its products meet all the claim limitations. Tr. 66:11–26.

Petitioner argues that Patent Owner has failed to meet its burden to establish nexus, because Patent Owner has not shown the required coextensiveness between the AirPods Products and the claims. Reply 30. Petitioner argues that Patent Owner does not allege the coextensiveness aspect of nexus. *Id*. Petitioner argues the evidence of nexus is based on a "subset of features recited in claim 1" and the setup process for the AirPods Products. *Id*. at 31 (citing PO Resp. 43–44). Petitioner concludes by arguing the allegations are conclusory and fail to establish a prima facie nexus. *Id*. (citing *Demaco Corp. v. F. Von Langsdorff Lic. Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988)).

Petitioner also lists several unclaimed features of the AirPods products including:

> (a) the first-generation AirPods had sensors that "detect when AirPods are in ear and can automatically play and pause music" [Ex. 2040], (b) the second generation AirPods had a proprietary system-in-package (SiP) chip (Apple H1 chip) that delivered "performance efficiencies, faster connect times, more talk time" [Ex. 2041], (c) the AirPods Pro had adaptive noise cancelling feature that "uses two microphones" on a single earphone "combined with advanced software. to continuously adapt to each individual ear and headphone fit" [Ex. 2042], and (d) all AirPods Products "feature the same great battery life . . . with up to five hours of listening time" [Ex. 2042].

Reply 31–32; *see also id*. at 32 (citing Ex. 1025, 240:12–15 (Mr. McAlexander testifying as to other unclaimed features of the AirPods Products)).

Petitioner also argues Patent Owner's evidence does not demonstrate commercial success that results directly from the "unique characteristics" of the claimed invention. Reply 32 (citing *In re Huang*, 100 F. 3d 135, 140 (Fed. Cir. 1996)).

In response, Patent Owner alleges it need not prove the claims are coextensive with the AirPods Products where there is proof "that ***the patentee demonstrate[s] that the product is essentially the claimed invention***." Sur-Reply 22–23 (citing *FOX Factory*, 944 F.3d at 1374). Notwithstanding the preceding argument, Patent Owner contends "several" of the alleged unclaimed features are claimed. *Id*. at 23. As an example, Patent Owner cites unclaimed feature (b) above from the Reply, the "(SiP) chip (Apple H1 chip)," arguing claim 1 recites a "processor circuit." *Id.* at 23. Patent Owner also argues claim 1 recites a "rechargeable battery," as meeting the alleged "great battery life" of unclaimed feature (d) above. *Id*. Noise cancelling is identified in unclaimed feature (c) above and is argued as the "sound quality enhancement" of claim 19. *Id*. Patent Owner argues it has shown three of the four unclaimed features are claimed. *Id*.

We find that Patent Owner has not met its burden of showing the requisite nexus — that the AirPods Products embody "the claimed features, and is coextensive with them." *Fox Factory*, 944 F.3d at 1373. Patent Owner's sole basis for asserting that the AirPods Products embody the claims is a claim chart from a separate litigation. Ex. 1014, 1003–1014, 1041–1052.

In any case, we agree with Petitioner that the Response did not allege the AirPods Products are coextensive with any claim. Reply 30. Further, Patent Owner misapprehends *Fox Factory* in alleging coextensiveness is

not required. *See Fox Factory*, 944 F.3d at 1376 ("On a broader note, if we were to agree . . . that the coextensiveness requirement is met so long as the patent claim broadly covers the product that is the subject of the secondary considerations evidence, irrespective of the nature of any unclaimed features — then the coextensiveness requirement would rest entirely on minor variations in claim drafting."). Moreover, we are not persuaded that the alleged unclaimed features, (a) through (d) of the Reply, are claimed. Patent Owner treats the claim language too broadly. Beyond attorney argument, we are not presented with proof that a "processor circuit" is coextensive with a chip is used on the AirPods to enhance "performance efficiencies, faster connect times, more talk time." Similarly, "great battery life" is not swallowed up by a claim limitation to a "rechargeable battery." Neither do we agree that Patent Owner has sufficiently shown that "sound quality enhancement" is noise cancellation.

Moreover, the question is whether the unclaimed features "materially impact the functionality of the . . . products." *Fox Factory*, 944 F.3d at 1376. *Fox Factory* did not hold that unclaimed features must be critical to or for improving the heart of the challenged claims. Rather, we look to whether the unclaimed features "materially impact[] the product's functionality." *Id.* at 1375. Thus, when *Fox Factory* states that "if the unclaimed features amount to nothing more than additional insignificant features, presuming nexus may nevertheless be appropriate," *id.* at 1374, it means insignificant to the product, not insignificant to the challenged claims. Patent Owner does not argue, and has not presented evidence, that the unclaimed features of AirPods Products are insignificant to, or do not materially impact, the AirPods Products. In sum, Patent Owner has not

shown nexus by virtue of the claims being coextensive with the allegedly successful products.

As noted above, Patent Owner may still show nexus by showing that the commercial success of AirPods Products is the direct result of the unique characteristics of the claimed invention. *See Fox Factory*, 944 F.3d at 1373–1374; *Huang*, 100 F.3d at 140. Although Patent Owner cites case law regarding nexus based on unique characteristics of the claimed invention, it does not argue what the characteristics are or provide supporting evidence. *See* PO Resp. 42–43 (citing *Demaco,* 851 F.2d at 1392; *Fox Factory,* 994 F.3d at 1373–1374).

Because Patent Owner has not shown a nexus between the claimed invention and the alleged commercial success, Patent Owner has not made a persuasive showing that commercial success evidences non-obviousness.

IV. CONCLUSION[26]

For the reasons discussed above, Petitioner has shown by a preponderance of the evidence that claims 1–5 and 14–18 of the '982 patent are unpatentable as summarized in the table below. Petitioner has not shown that challenged claims 19 and 20 are unpatentable.

[26] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. §§ 42.8(a)(3), (b)(2).

In summary:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 18–20	103	Rosener, Hankey or Rosener, Hankey, Dyer	1, 2, 18	19, 20
3–5	103	Rosener, Hankey, Haupt or Rosener, Hankey, Dyer, Haupt	3–5	
14	103	Rosener, Hankey, Price or Rosener, Hankey, Dyer, Price	14	
15	103	Rosener, Hankey, Paulson or Rosener, Hankey, Dyer, Paulson	15	
16, 17	103	Rosener, Hankey, Huddart or Rosener, Hankey, Dyer, Huddart	16, 17	
17	103	Rosener, Hankey, Huddart, Vanderelli or Rosener, Hankey, Dyer, Huddart, Vanderelli	17	
Overall Outcome			1–5, 14–18	19, 20

V. Order

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has shown that challenged claims 1–5 and 14–18 are unpatentable;

FURTHER ORDERED that Petitioner has not shown that challenged claims 19 and 20 are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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(12) **United States Patent**
Koss et al.

(10) **Patent No.: US 10,506,325 B1**
(45) **Date of Patent: *Dec. 10, 2019**

(54) **SYSTEM WITH WIRELESS EARPHONES**

(71) Applicant: **Koss Corporation**, Milwaukee, WI (US)

(72) Inventors: **Michael J. Koss**, Milwaukee, WI (US); **Michael J. Pelland**, Princeton, WI (US); **Michael Sagan**, Fairfield, CA (US); **Steven R. Reckamp**, Crystal Lake, IL (US); **Gregory J. Hallingstad**, Deforest, WI (US); **Jeffery K. Bovee**, Sterling, IL (US); **Morgan J. Lowery**, Deforest, WI (US)

(73) Assignee: **KOSS CORPORATION**, Milwaukee, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/528,703**

(22) Filed: **Aug. 1, 2019**

Related U.S. Application Data

(63) Continuation of application No. 16/375,879, filed on Apr. 5, 2019, which is a continuation of application
(Continued)

(51) **Int. Cl.**
H04R 1/10 (2006.01)
H04W 48/20 (2009.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04R 1/1041*** (2013.01); ***H03G 3/02*** (2013.01); ***H03K 17/9622*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04R 2201/107; H04R 1/02; H04R 5/033
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,784,685 A 7/1998 Stanford et al.
6,006,115 A 12/1999 Wingate
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2004-320597 11/2004
JP 2008-67258 A 3/2008
(Continued)

OTHER PUBLICATIONS

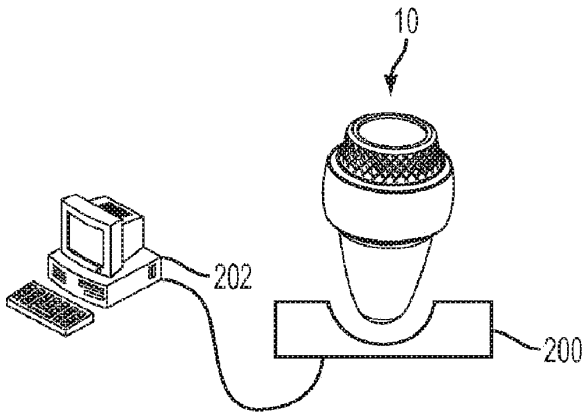
Supplementary European Search Report for European Application No. 09731146.8 dated Jun. 10, 2011, 7 pages.
(Continued)

Primary Examiner — Kiet M Doan
(74) *Attorney, Agent, or Firm* — K&L Gates LLP

(57) **ABSTRACT**

Apparatus comprises adapter and speaker system. Adapter is configured to plug into port of personal digital audio player. Speaker system is in communication with adapter, and comprises multiple acoustic transducers, programmable processor circuit, and wireless communication circuit. In first operational mode, processor circuit receives, via adapter, and processes digital audio content from personal digital audio player into which adapter is plugged, and the multiple acoustic transducers output the received audio content from the personal digital audio player. In second operational mode, wireless communication circuit receives digital audio content from a remote digital audio source over a wireless network, processor circuit processes the digital audio content received from remote digital audio source, and the multiple acoustic transducers output the audio content received from the remote digital audio source.

18 Claims, 16 Drawing Sheets



Related U.S. Application Data

No. 16/182,927, filed on Nov. 7, 2018, now Pat. No. 10,368,155, which is a continuation of application No. 15/962,305, filed on Apr. 25, 2018, now Pat. No. 10,206,025, which is a continuation of application No. 15/650,362, filed on Jul. 14, 2017, now Pat. No. 9,986,325, which is a continuation of application No. 15/293,785, filed on Oct. 14, 2016, now Pat. No. 9,729,959, which is a continuation of application No. 15/082,040, filed on Mar. 28, 2016, now Pat. No. 9,497,535, which is a continuation of application No. 14/695,696, filed on Apr. 24, 2015, now Pat. No. 9,438,987, which is a continuation of application No. 13/609,409, filed on Sep. 11, 2012, now Pat. No. 9,049,502, which is a continuation of application No. 13/459,291, filed on Apr. 30, 2012, now Pat. No. 8,571,544, which is a continuation of application No. 12/936,488, filed as application No. PCT/US2009/039754 on Apr. 7, 2009, now Pat. No. 8,190,203.

(60) Provisional application No. 61/123,265, filed on Apr. 7, 2008.

(51) **Int. Cl.**

H04M 1/02	(2006.01)
H04R 3/00	(2006.01)
H04R 5/033	(2006.01)
H04R 5/04	(2006.01)
H03G 3/02	(2006.01)
H04R 1/02	(2006.01)
H04L 29/12	(2006.01)
H04H 20/95	(2008.01)
H03K 17/96	(2006.01)
H04W 4/80	(2018.01)
H04W 84/12	(2009.01)
H04W 84/18	(2009.01)
H04R 25/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H04H 20/95*** (2013.01); ***H04L 61/6068*** (2013.01); ***H04M 1/0254*** (2013.01); ***H04R 1/02*** (2013.01); ***H04R 1/1091*** (2013.01); ***H04R 3/00*** (2013.01); ***H04R 5/033*** (2013.01); ***H04R 5/04*** (2013.01); ***H04W 4/80*** (2018.02); ***H04W 48/20*** (2013.01); *H03K 2217/960785* (2013.01); *H04R 25/554* (2013.01); *H04R 2201/103* (2013.01); *H04R 2201/107* (2013.01); *H04R 2225/55* (2013.01); *H04R 2420/07* (2013.01); *H04W 84/12* (2013.01); *H04W 84/18* (2013.01)

(58) **Field of Classification Search**

USPC 381/74, 380, 375, 364, 381; 455/42, 557, 455/41.3, 573, 466, 569.1, 553.1

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,389,463	B2	5/2002	Bolas	
6,671,494	B1	12/2003	James	
6,674,864	B1	1/2004	Kitamura	
6,792,091	B2	9/2004	Lemchen et al.	
6,937,712	B2	8/2005	Lemchen et al.	
7,003,515	B1	2/2006	Glaser	
7,027,311	B2	4/2006	Vanderelli	
7,095,455	B2	8/2006	Jordan	
7,099,370	B2	8/2006	Takahashi	
7,120,388	B2	10/2006	Hall	
7,139,585	B2	11/2006	Hachimura et al.	
7,266,390	B2	9/2007	Mathews	
7,337,027	B2	2/2008	Nishiguchi et al.	
7,467,021	B2	12/2008	Yuen	
7,512,414	B2	3/2009	Jannard et al.	
7,599,679	B2	10/2009	Awiszus	
7,650,168	B2	1/2010	Bailey	
7,680,490	B2	3/2010	Bloebaum et al.	
7,697,899	B2	4/2010	Rofougaran	
7,734,055	B2	6/2010	Chiloyan	
7,764,775	B2	7/2010	Tarkoff et al.	
7,805,210	B2	9/2010	Cucos	
7,861,312	B2	12/2010	Lee et al.	
7,962,482	B2	6/2011	Handman	
8,023,663	B2	9/2011	Goldberg	
8,027,638	B2	9/2011	Sanguino	
8,055,007	B2	11/2011	Kim	
8,073,137	B2	12/2011	Weinans et al.	
8,086,281	B2	12/2011	Rabu et al.	
8,102,836	B2	1/2012	Jerlhagen	
8,190,203	B2	5/2012	Pelland et al.	
8,295,516	B2	10/2012	Kondo et al.	
8,335,312	B2	12/2012	Gerhardt et al.	
8,401,202	B2	3/2013	Brooking	
8,478,880	B2	7/2013	Finkelstein et al.	
8,483,755	B2	7/2013	Kumar	
8,553,865	B2	10/2013	Menard et al.	
8,571,544	B2	10/2013	Pelland et al.	
8,655,420	B1	2/2014	Pelland et al.	
8,792,945	B2	7/2014	Russell et al.	
9,049,502	B2	6/2015	Pelland et al.	
9,497,535	B1	11/2016	Koss et al.	
9,729,959	B2	8/2017	Koss et al.	
2003/0182003	A1	9/2003	Takashima	
2004/0107271	A1	6/2004	Ahn et al.	
2005/0064853	A1	3/2005	Radpour	
2005/0136839	A1	6/2005	Seshadri et al.	
2005/0198233	A1	9/2005	Manchester	
2006/0083388	A1	4/2006	Rothschild	
2006/0206487	A1	9/2006	Harada	
2006/0212442	A1	9/2006	Conrad	
2006/0212444	A1	9/2006	Handman et al.	
2006/0238878	A1	10/2006	Miyake	
2006/0268830	A1	11/2006	Evans	
2007/0008984	A1	1/2007	Philips	
2007/0037615	A1	2/2007	Glezerman	
2007/0049198	A1	3/2007	Walsh et al.	
2007/0053543	A1	3/2007	Lee	
2007/0136446	A1	6/2007	Rezvani et al.	
2007/0165875	A1	7/2007	Rezvani	
2007/0253603	A1	11/2007	Kimura et al.	
2007/0297618	A1	12/2007	Nurmi et al.	
2008/0019557	A1	1/2008	Bevirt et al.	
2008/0031470	A1	2/2008	Angelhag	
2008/0062939	A1	3/2008	Van Horn	
2008/0076489	A1*	3/2008	Rosener	H04M 1/6066 455/575.2
2008/0194209	A1	8/2008	Haupt et al.	
2008/0215777	A1	9/2008	Richenstein et al.	
2008/0226094	A1	9/2008	Rutschman	
2008/0242312	A1	10/2008	Paulson et al.	
2008/0298606	A1	12/2008	Johnson et al.	
2008/0311852	A1	12/2008	Hansen et al.	
2009/0029743	A9	1/2009	Lair et al.	
2009/0109054	A1*	4/2009	Ueda	H04M 1/04 340/13.24
2009/0116678	A1	5/2009	Bevirt et al.	
2009/0129605	A1	5/2009	Camp et al.	
2009/0248178	A1	10/2009	Paulson et al.	
2010/0290642	A1	11/2010	Haseagawa	
2011/0275323	A1	11/2011	Goldman et al.	
2013/0039510	A1	2/2013	Pelland et al.	
2013/0099507	A1	4/2013	Moriya et al.	
2015/0237439	A1	8/2015	Koss et el.	
2017/0318378	A1	11/2017	Koss et al.	
2018/0249240	A1	8/2018	Koss et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2019/0075390	A1	3/2019	Koss et al.
2019/0238970	A1	8/2019	Koss et al.

FOREIGN PATENT DOCUMENTS

WO	WO 2006/047724	A2	5/2006
WO	WO 2007/136620	A2	11/2007
WO	WO 2007/139578	A1	12/2007
WO	WO 2008/033478	A1	3/2008
WO	WO 2008/054985	A2	5/2008
WO	WO 2009/086555	A1	7/2009

OTHER PUBLICATIONS

International Search Report for International Application No. PCT/US09/39754 dated Jun. 11, 2009, 2 pages.
International Preliminary Examination Report for International Application No. PCT/US09/39754 dated Oct. 28, 2010, 8 pages.
Written Opinion of the International Searching Authority for International Application No. PCT/US09/39754 dated Jun. 11, 2009, 5 pages.
IT Review, "LTB 802.11 WiFi Headphones", http://itreview.belproject.com/item/1536 accessed on Mar. 13, 2008 (4 pages).

* cited by examiner

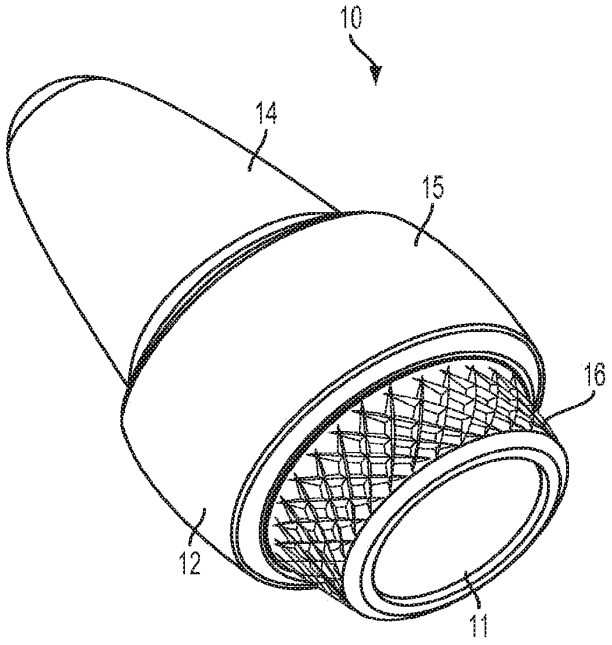


FIG. 1A

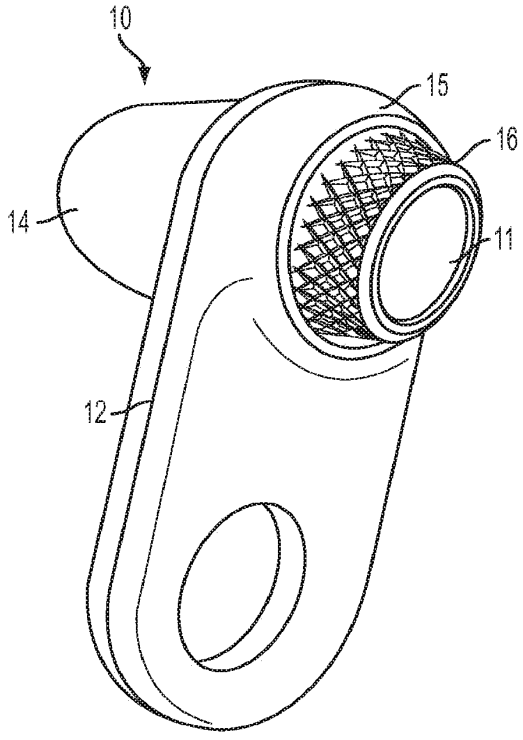


FIG. 1B

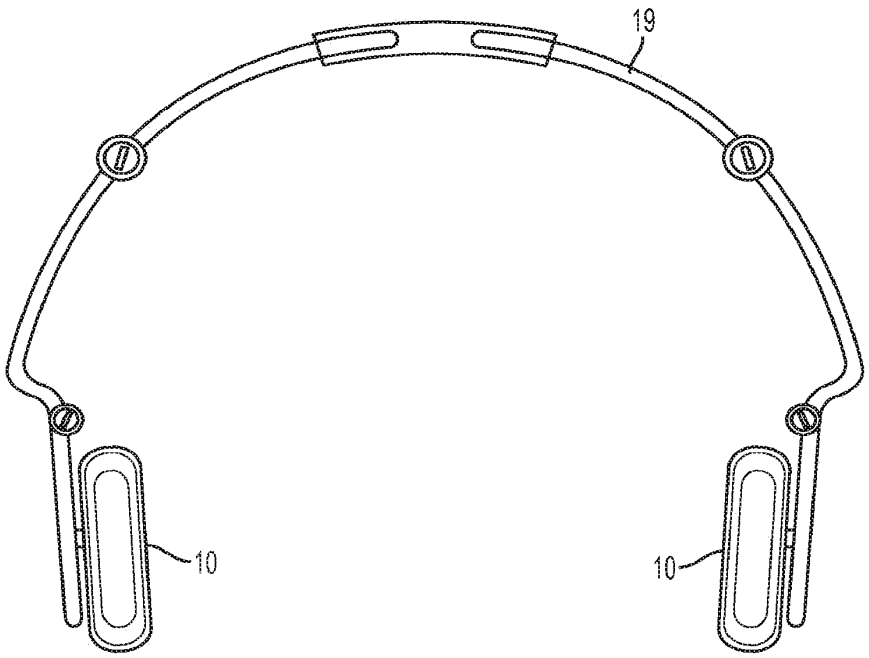


FIG. 1C

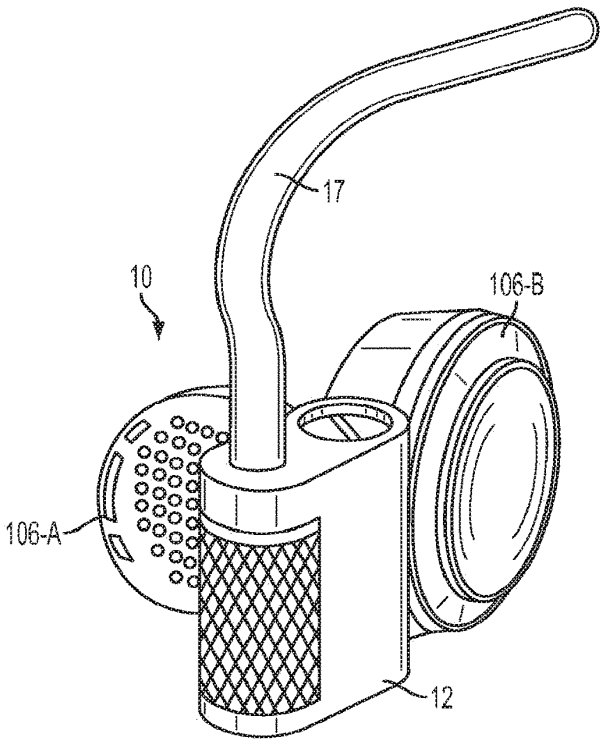


FIG. 1D

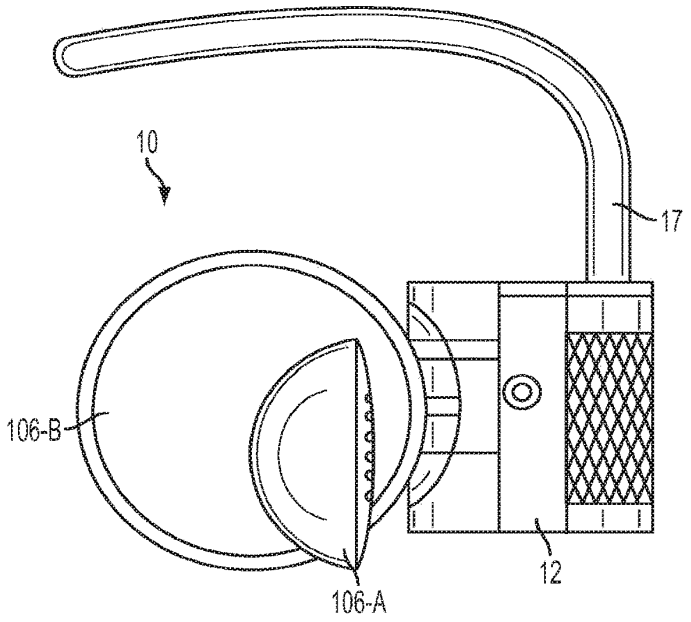


FIG. 1E

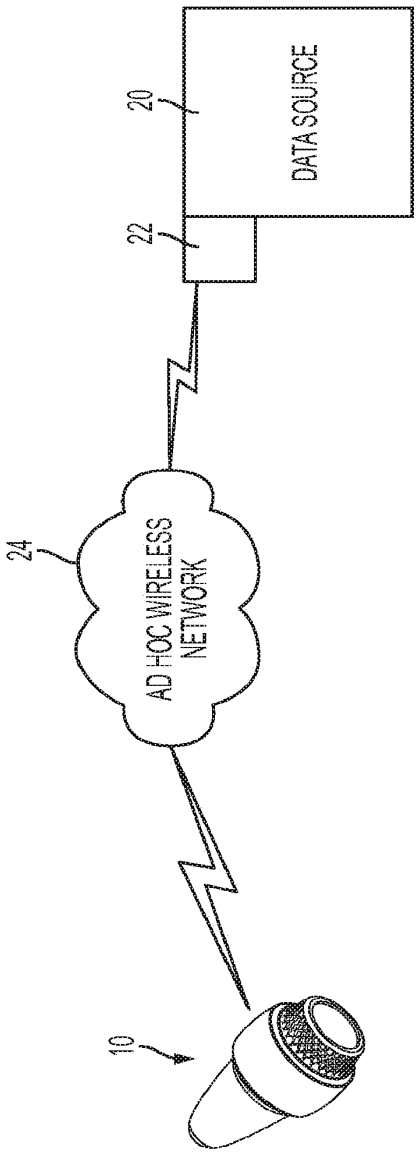


FIG. 2A

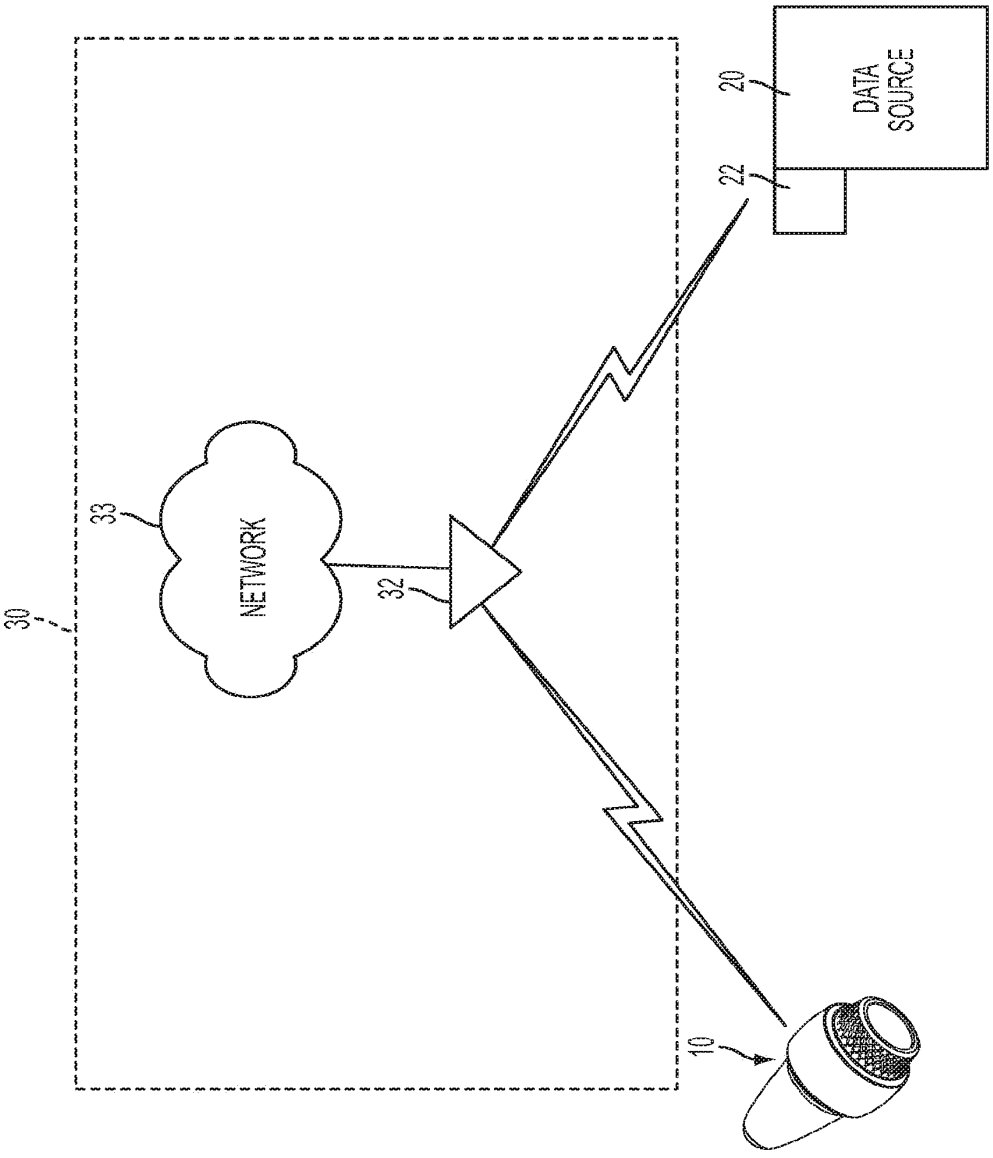


FIG. 2B

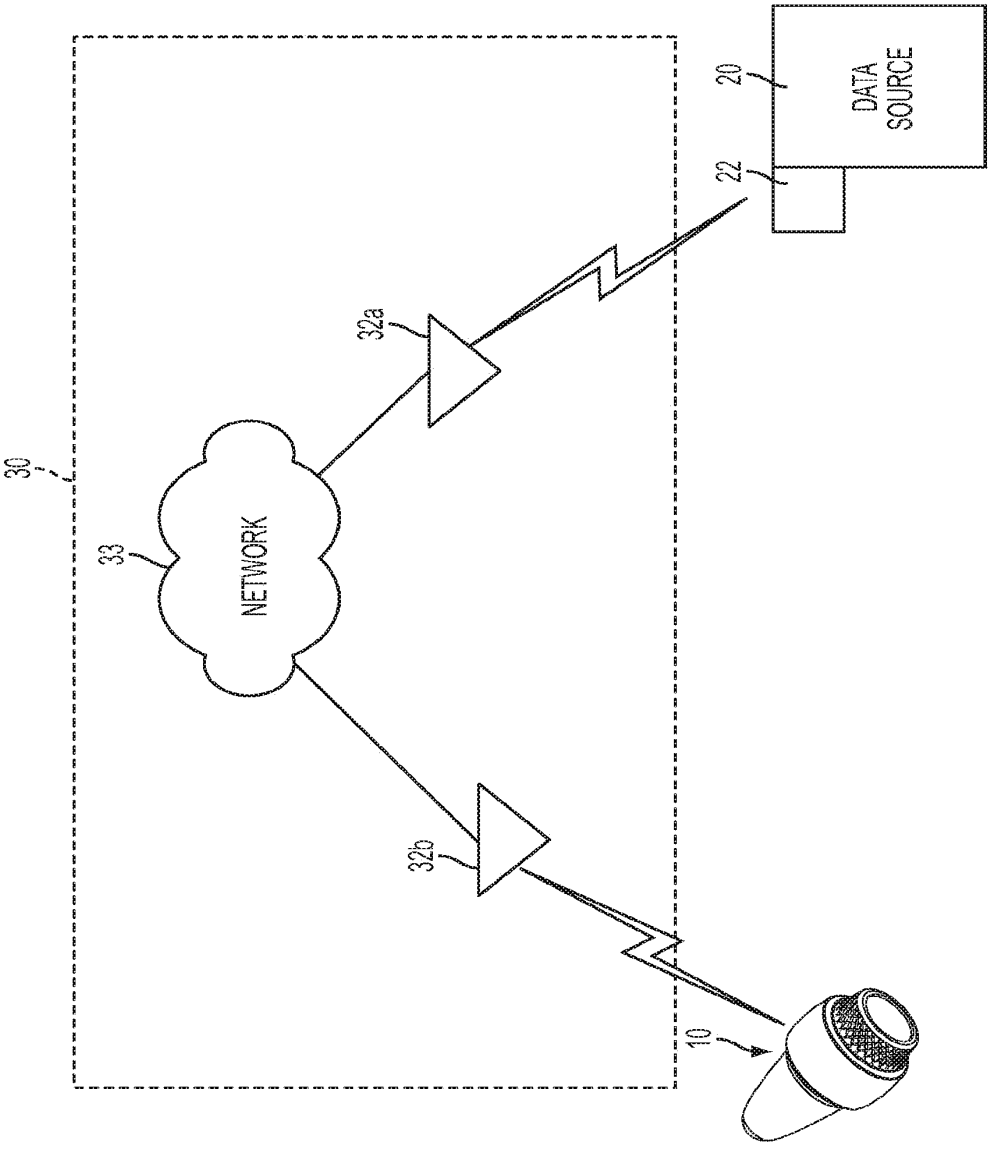


FIG. 2C

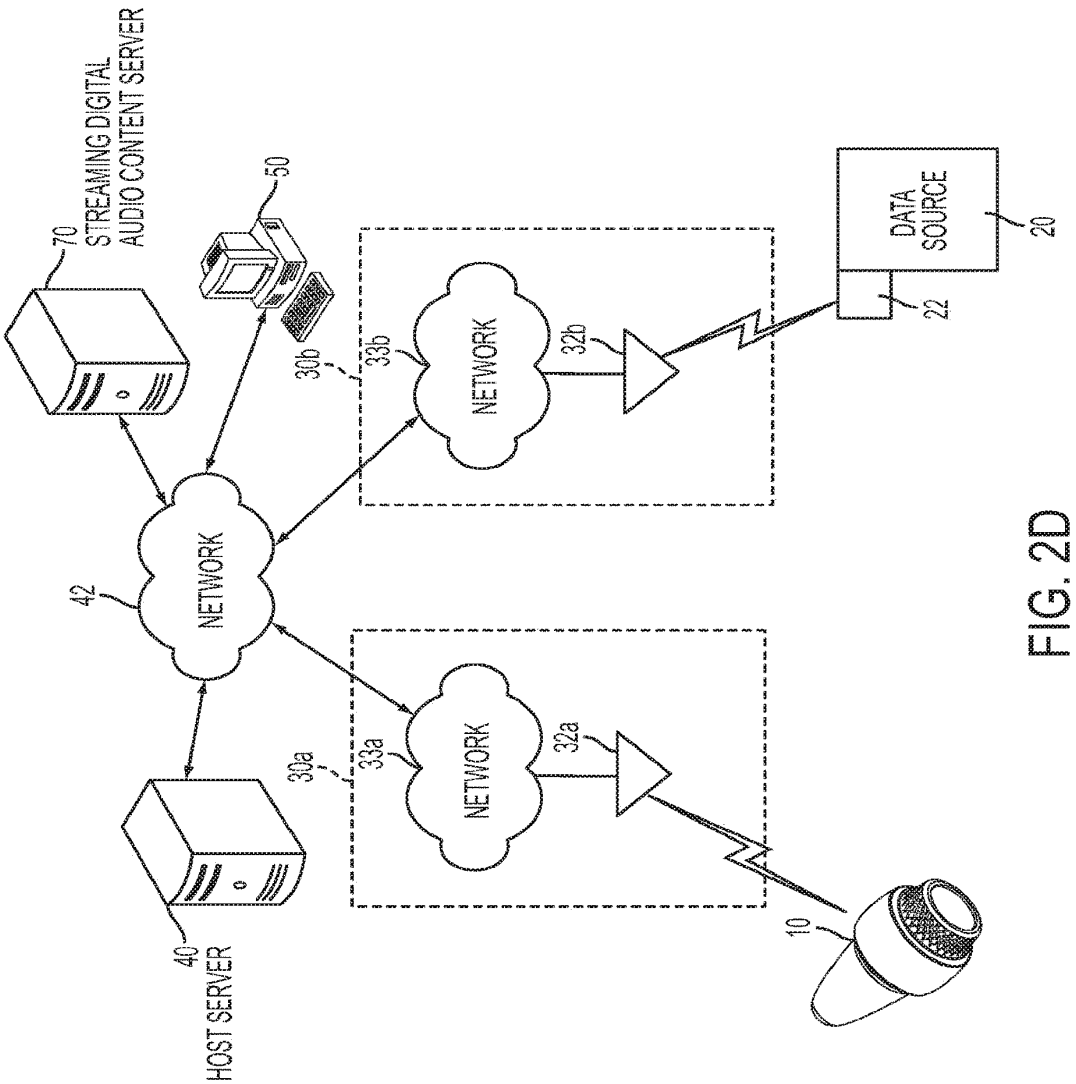

STREAMING DIGITAL AUDIO CONTENT SERVER
70
50
30b
33b
NETWORK
32b
DATA SOURCE
20
22
42
NETWORK
30a
33a
NETWORK
32a
40
HOST SERVER
10

FIG. 2D

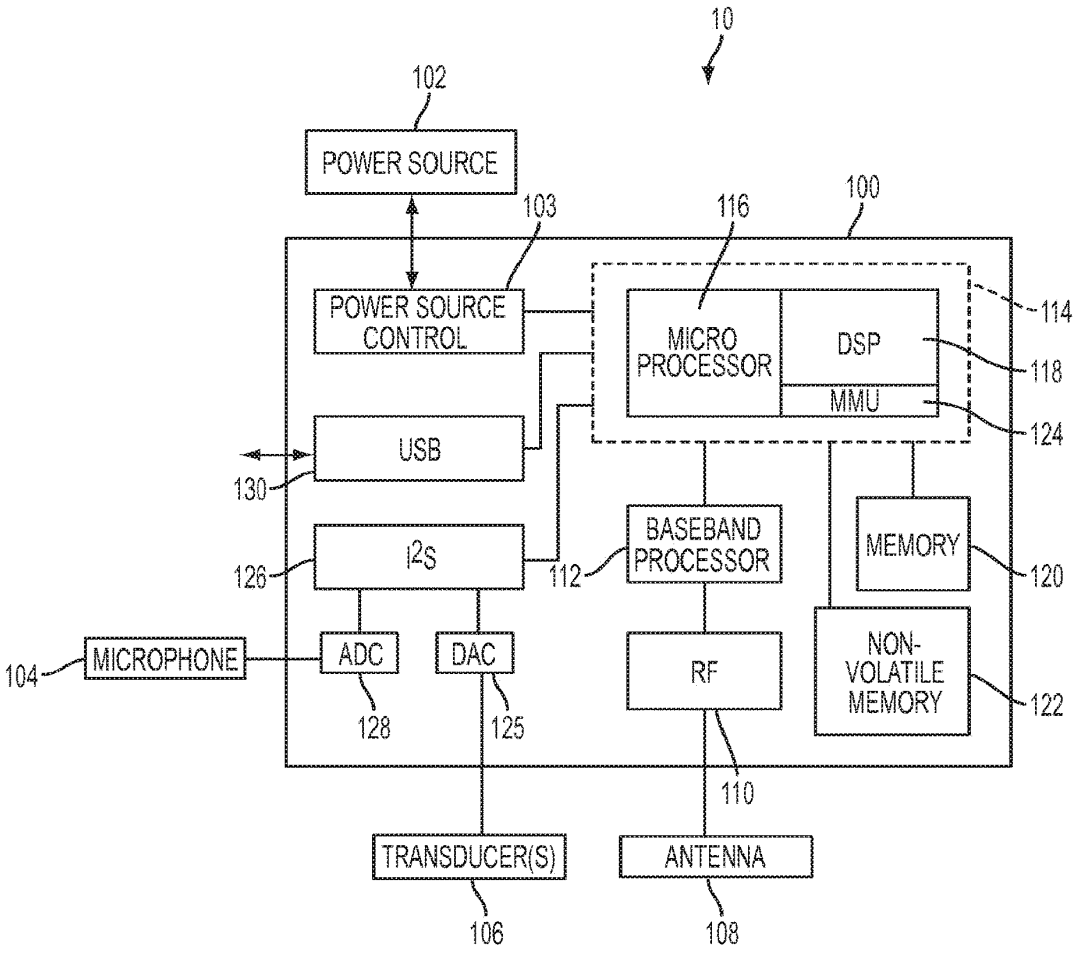

10
102
POWER SOURCE
103
116
100
POWER SOURCE CONTROL
MICRO PROCESSOR
DSP
MMU
114
118
124
USB
130
BASEBAND PROCESSOR
MEMORY
I2S
126
112
120
MICROPHONE
104
ADC
DAC
RF
NON-VOLATILE MEMORY
122
128
125
110
TRANSDUCER(S)
ANTENNA
106
108

FIG. 3

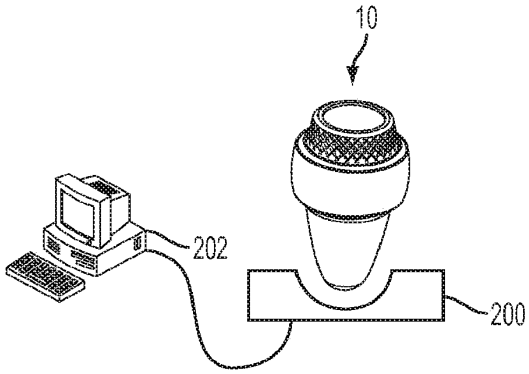


FIG. 4A

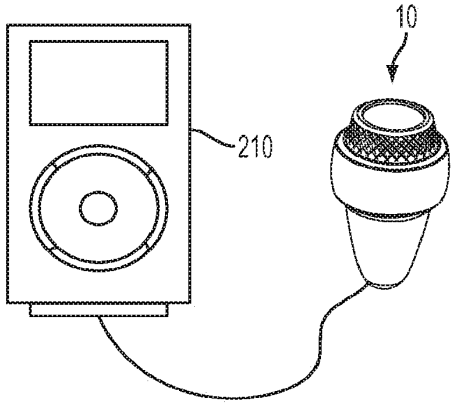


FIG. 4B

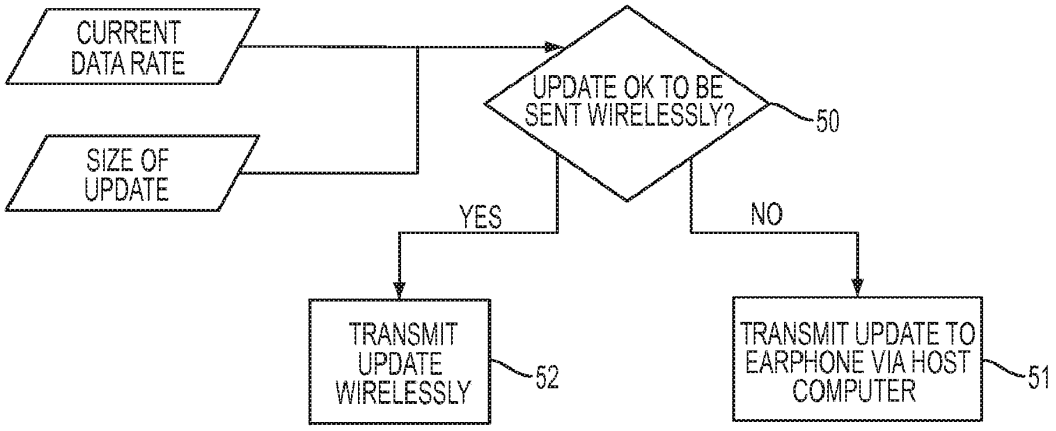

CURRENT DATA RATE
SIZE OF UPDATE
UPDATE OK TO BE SENT WIRELESSLY?
50
YES
NO
TRANSMIT UPDATE WIRELESSLY
52
TRANSMIT UPDATE TO EARPHONE VIA HOST COMPUTER
51

FIG. 5

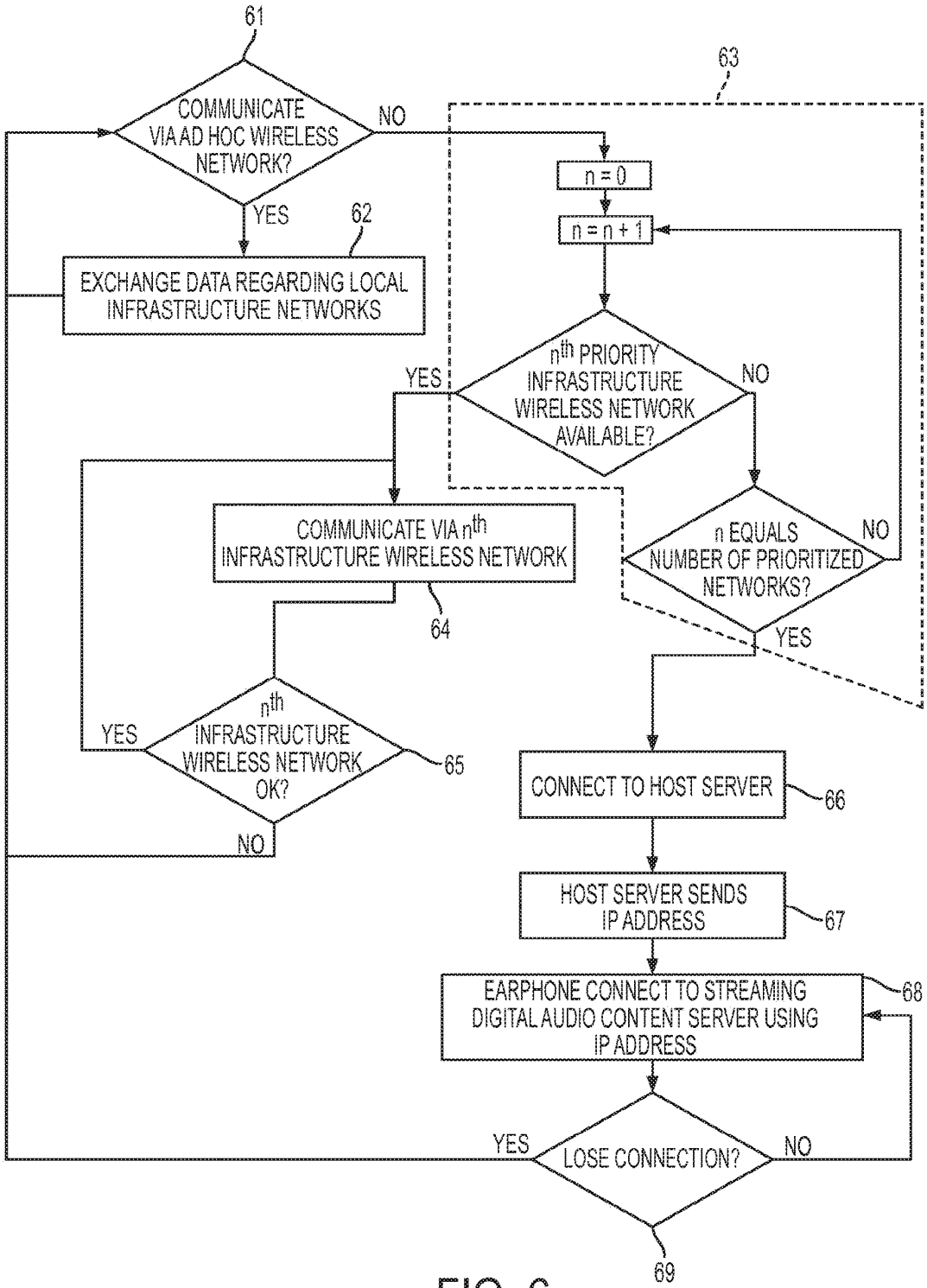

61
COMMUNICATE VIA AD HOC WIRELESS NETWORK?
NO
YES
62
EXCHANGE DATA REGARDING LOCAL INFRASTRUCTURE NETWORKS
63
n = 0
n = n + 1
nth PRIORITY INFRASTRUCTURE WIRELESS NETWORK AVAILABLE?
YES
NO
COMMUNICATE VIA nth INFRASTRUCTURE WIRELESS NETWORK
64
n EQUALS NUMBER OF PRIORITIZED NETWORKS?
NO
YES
nth INFRASTRUCTURE WIRELESS NETWORK OK?
YES
65
NO
CONNECT TO HOST SERVER
66
HOST SERVER SENDS IP ADDRESS
67
EARPHONE CONNECT TO STREAMING DIGITAL AUDIO CONTENT SERVER USING IP ADDRESS
68
LOSE CONNECTION?
YES
NO
69

FIG. 6

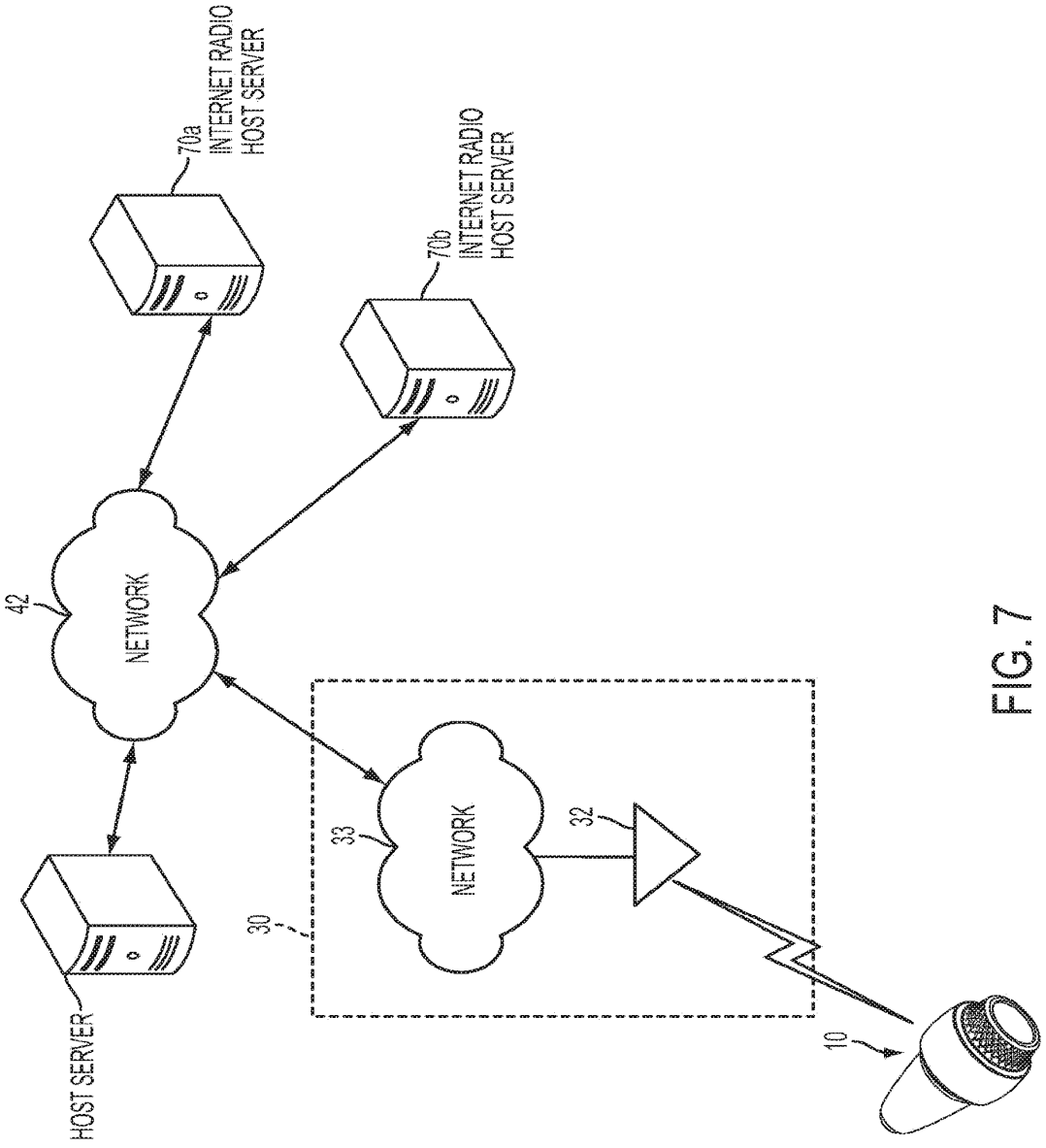

70a
INTERNET RADIO
HOST SERVER
70b
INTERNET RADIO
HOST SERVER
42
NETWORK
33
NETWORK
32
30
HOST SERVER
10

FIG. 7

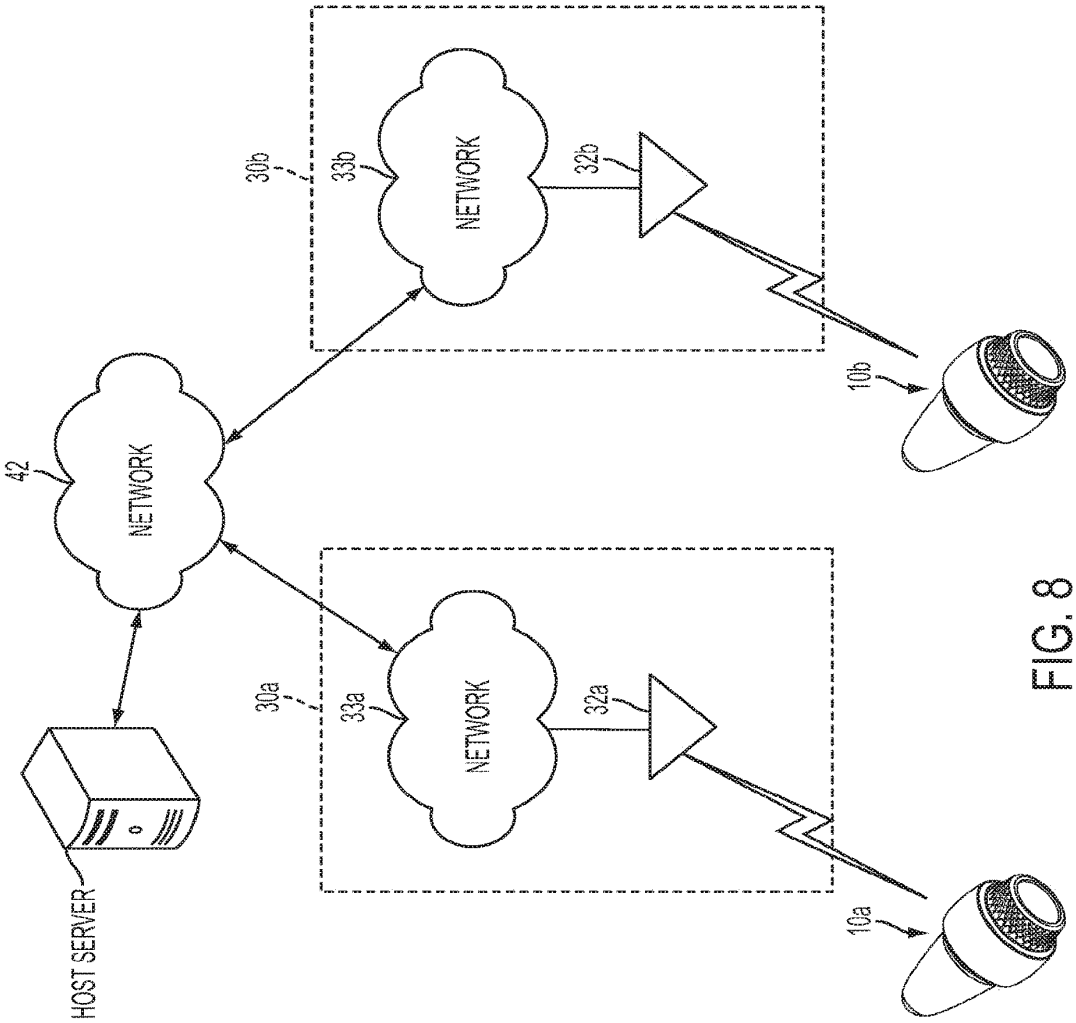

NETWORK
42
30b
33b
NETWORK
32b
10b
30a
33a
NETWORK
32a
10a
HOST SERVER

FIG. 8

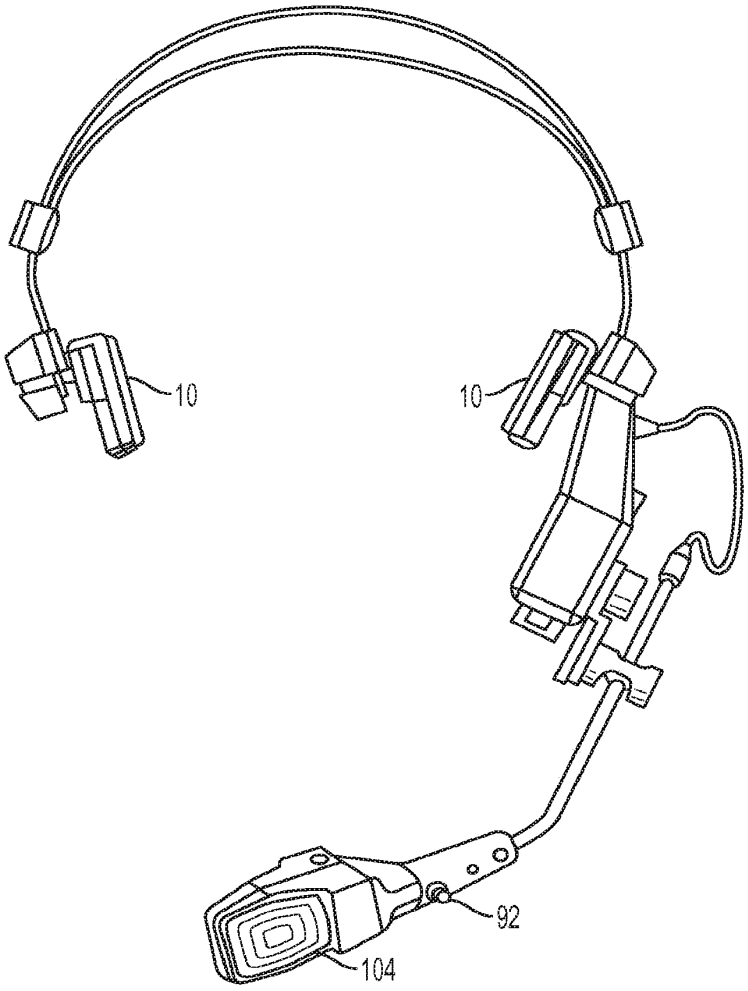


FIG. 9

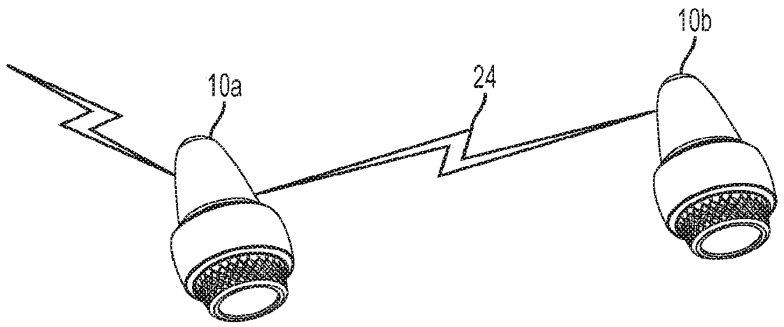


FIG. 10

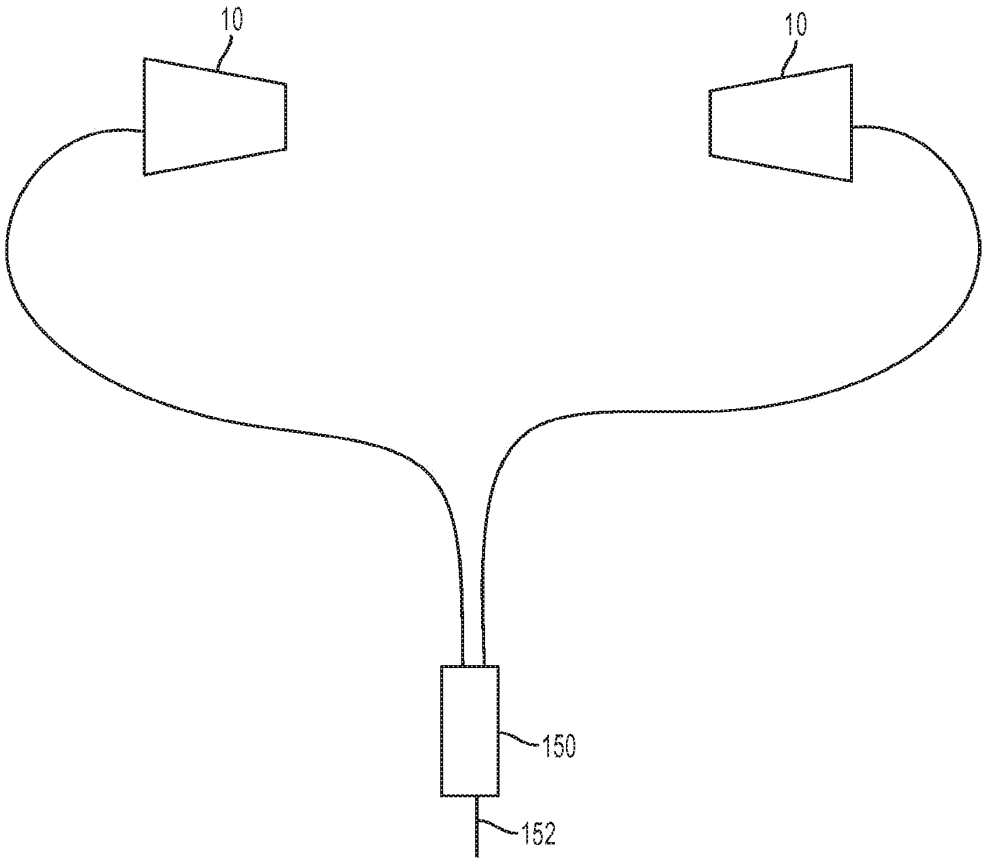


FIG. 11

SYSTEM WITH WIRELESS EARPHONES

PRIORITY CLAIM

The present application claims priority as a continuation to U.S. nonprovisional patent application Ser. No. 16/375,879, filed Apr. 5, 2019, which is a continuation of U.S. nonprovisional patent application Ser. No. 16/182,927, filed Nov. 7, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/962,305, filed Apr. 25, 2018, now U.S. Pat. No. 10,206,025, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/650,362, filed Jul. 14, 2017, now U.S. Pat. No. 9,986,325, issued May 29, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/293,785, filed Oct. 14, 2016, now U.S. Pat. No. 9,729,959, issued Aug. 8, 2017, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/082,040, filed Mar. 28, 2016, now U.S. Pat. No. 9,497,535, issued Nov. 15, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 14/695,696, filed Apr. 24, 2015, now U.S. Pat. No. 9,438,987, issued on Sep. 6, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, issued Jun. 2, 2015, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/459,291, filed Apr. 30, 2012, now U.S. Pat. No. 8,571,544, issued Oct. 29, 2013, which is a continuation of U.S. patent application Ser. No. 12/936,488, filed Dec. 20, 2010, now U.S. Pat. No. 8,190,203, issued May 29, 2012, which is a national stage entry of PCT/US2009/039754, filed Apr. 7, 2009, which claims priority to U.S. provisional patent application Ser. No. 61/123,265, filed Apr. 7, 2008, all of which are incorporated herein by reference in their entireties.

CROSS-REFERENCE TO RELATED APPLICATIONS

U.S. nonprovisional patent application Ser. No. 14/031,938, filed Sep. 13, 2013, now U.S. Pat. No. 8,655,420, issued Feb. 18, 2014, is also a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, mentioned above.

BACKGROUND

Digital audio players, such as MP3 players and iPods, that store and play digital audio files, are very popular. Such devices typically comprise a data storage unit for storing and playing the digital audio, and a headphone set that connects to the data storage unit, usually with a ¼" or a 3.5 mm jack and associated cord. Often the headphones are in-ear type headphones. The cord, however, between the headphones and the data storage unit can be cumbersome and annoying to users, and the length of the cord limits the physical distance between the data storage unit and the headphones. Accordingly, some cordless headphones have been proposed, such as the Monster iFreePlay cordless headphones from Apple Inc., which include a docking port on one of the earphones that can connect directly to an iPod Shuffle. Because they have the docking port, however, the Monster iFreePlay cordless headphones from Apple are quite large and are not in-ear type phones. Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but such headphones are also quite large and not in-ear type phones.

SUMMARY

In one general aspect, the present invention is directed to a wireless earphone that comprises a transceiver circuit for receiving streaming audio from a data source, such as a digital audio player or a computer, over an ad hoc wireless network. When the data source and the earphone are out of range via the ad hoc wireless network, they may transition automatically to a common infrastructure wireless network (e.g., a wireless LAN). If there is no common infrastructure wireless network for both the data source and the earphone, the earphone may connect via an available infrastructure wireless network to a host server. The host server may, for example, broadcast streaming audio to the earphone and/or transmit to the earphone a network address (e.g., an Internet Protocol (IP) address) for a network-connected content server that streams digital audio. The earphone may then connect to the content server using the IP address. The content server may be an Internet radio server, including, for example, an Internet radio server that broadcasts streaming audio from the data source or some other content.

These and other advantageous, unique aspects of the wireless earphone are described below.

FIGURES

Various embodiments of the present invention are described herein by way of example in conjunction with the following figures, wherein:

FIGS. **1**A-**1**E are views of a wireless earphone according to various embodiments of the present invention;

FIGS. **2**A-**2**D illustrate various communication modes for a wireless earphone according to various embodiments of the present invention;

FIG. **3** is a block diagram of a wireless earphone according to various embodiments of the present invention;

FIGS. **4**A-**4**B show the wireless earphone connected to another device according to various embodiments of the present invention;

FIG. **5** is a diagram of a process implemented by a host server according to various embodiments of the present invention;

FIG. **6** is a diagram of a process implemented by the wireless earphone to transition automatically between wireless networks according to various embodiments of the present invention;

FIGS. **7**, **8** and **10** illustrate communication systems involving the wireless earphone according to various embodiments of the present invention;

FIG. **9** is a diagram of a headset including a wireless earphone and a microphone according to various embodiments of the present invention; and

FIG. **11** is a diagram of a pair of wireless earphones with a dongle according to various embodiments of the present invention.

DESCRIPTION

In one general aspect, the present invention is directed to a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks. The earphone may comprise one or more in-ear, on-ear, or over-ear speaker elements. Two exemplary in-ear earphone shapes for the wireless earphone **10** are shown in FIGS. **1**A and **1**B, respectively, although in other embodiments the earphone may take different shapes and the exemplary

shapes shown in FIGS. **1**A and **1**B are not intended to be limiting. In one embodiment, the earphone transitions automatically and seamlessly, without user intervention, between communication modes. That is, the earphone may transition automatically from an ad hoc wireless network to an infrastructure wireless network, without user intervention. As used herein, an "ad hoc wireless network" is a network where two (or more) wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point. An "infrastructure wireless network," on the other hand, is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet).

FIGS. **1**A and **1**B show example configurations for a wireless earphone **10** according to various embodiments of the present invention. The examples shown in FIGS. **1**A and **1**B are not limiting and other configurations are within the scope of the present invention. As shown in FIGS. **1**A and **1**B, the earphone **10** may comprise a body **12**. The body **12** may comprise an ear canal portion **14** that is inserted in the ear canal of the user of the earphone **10**. In various embodiments, the body **12** also may comprise an exterior portion **15** that is not inserted into user's ear canal. The exterior portion **15** may comprise a knob **16** or some other user control (such as a dial, a pressure-activated switch, lever, etc.) for adjusting the shape of the ear canal portion **14**. That is, in various embodiments, activation (e.g. rotation) of the knob **16** may cause the ear canal portion **14** to change shape so as to, for example, radially expand to fit snugly against all sides of the user's ear canal. Further details regarding such a shape-changing earbud earphone are described in application PCT/US08/88656, filed 31 Dec. 2008, entitled "Adjustable Shape Earphone," which is incorporated herein by reference in its entirety. The earphone **10** also may comprise a transceiver circuit housed within the body **12**. The transceiver circuit, described further below, may transmit and receive the wireless signals, including receive streaming audio for playing by the earphone **10**. The transceiver circuit may be housed in the exterior portion **15** of the earphone **10** and/or in the ear canal portion **14**.

Although the example earphones **10** shown in FIGS. **1**A and **1**B include a knob **16** for adjusting the shape of the ear canal portion **14**, the present invention is not so limited, and in other embodiments, different means besides a knob **16** may be used to adjust the ear canal portion **14**. In addition, in other embodiments, the earphone **10** may not comprise a shape-changing ear canal portion **14**.

In various embodiments, the user may wear two discrete wireless earphones **10**: one in each ear. In such embodiments, each earphone **10** may comprise a transceiver circuit. In such embodiments, the earphones **10** may be connected by a string or some other cord-type connector to keep the earphones **10** from being separated.

In other embodiments, as shown in FIG. **1**C, a headband **19** may connect the two (left and right) earphones **10**. The headband **19** may be an over-the-head band, as shown in the example of FIG. **1**C, or the headband may be a behind-the-head band. In embodiments comprising a headband **19**, each earphone **10** may comprise a transceiver circuit; hence, each earphone **10** may receive and transmit separately the wireless communication signals. In other embodiments comprising a headband **19**, only one earphone **10** may comprise the transceiver circuit, and a wire may run along the headband **19** to the other earphone **10** to connect thereby the transceiver circuit to the acoustic transducer in the earphone that does not comprise the transceiver circuit. The embodiment shown in FIG. **1**C comprises on-ear earphones **10**; in other embodiments, in-ear or over-ear earphones may be used.

In other embodiments, the earphone **10** may comprise a hanger bar **17** that allows the earphone **10** to clip to, or hang on, the user's ear, as shown in the illustrated embodiment of FIGS. **1**D-**1**E. FIG. **1**D is a perspective view of the earphone and FIG. **1**E is a side view according to one embodiment. As shown in the illustrated embodiment, the earphone **10** may comprise dual speaker elements **106**-A, **106**-B. One of the speaker elements (the smaller one) **106**-A is sized to fit into the cavum concha of the listener's ear and the other element (the larger one) **106**-B is not. The listener may use the hanger bar to position the earphone on the listener's ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener's ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user. More details regarding such a dual element, adjustable earphone may be found in U.S. provisional patent application Ser. No. 61/054,238, which is incorporated herein by reference in its entirety.

FIGS. **2**A-**2**D illustrate various communication modes for a wireless data communication system involving the earphone **10** according to embodiments of the present invention. As shown in FIG. **2**A, the system comprises a data source **20** in communication with the earphone **10** via an ad hoc wireless network **24**. The earphone **10**, via its transceiver circuit (described in more detail below), may communicate wirelessly with a data source **20**, which may comprise a wireless network adapter **22** for transmitting the digital audio wirelessly. For example, the data source **20** may be a digital audio player (DAP), such as an mp3 player or an iPod, or any other suitable digital audio playing device, such as a laptop or personal computer, that stores and/or plays digital audio files. In other embodiments, the data source **20** may generate analog audio, and the wireless network adapter **22** may encode the analog audio into digital format for transmission to the earphone **10**.

The wireless network adapter **22** may be an integral part of the data source **20**, or it may be a separate device that is connected to the data source **20** to provide wireless connectivity for the data source **20**. For example, the wireless network adapter **22** may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source **20** (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network (e.g., the ad hoc wireless network **24** or an infrastructure wireless network). The digital audio transmitted from the data source **20** to the earphone **10** via the wireless networks may comprise compressed or uncompressed audio. Any suitable file format may be used for the audio, including mp3, lossy or lossless WMA, Vorbis, Musepack, FLAC, WAV, AIFF, AU, or any other suitable file format.

When in range, the data source **20** may communicate with the earphone **10** via the ad hoc wireless network **24** using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.11a/b/g/n), WiMAX (IEEE 802.16), Bluetooth, Zigbee, UWB, or any other suitable wireless communication protocol. For purposes of the description to follow, it is assumed that the data source **20** and the earphone **10** communicate using a Wi-Fi protocol, although the invention is not so limited and other wireless communication

protocols may be used in other embodiments of the invention. The data source **20** and the earphone **10** are considered in range for the ad hoc wireless network **24** when the signal strengths (e.g., the RSSI) of the signals received by the two devices are above a threshold minimum signal strength level. For example, the data source **20** and the earphone **10** are likely to be in range for an ad hoc wireless network when then are in close proximity, such as when the wearer of the earphone **10** has the data source **20** on his/her person, such as in a pocket, strapped to their waist or arm, or holding the data source in their hand.

When the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, that is, when the received signals degrade below the threshold minimum signal strength level, both the earphone **10** and the data source **20** may transition automatically to communicate over an infrastructure wireless network (such as a wireless LAN (WLAN)) **30** that is in the range of both the earphone **10** and the data source **20**, as shown in FIG. **2**B. The earphone **10** and the data source **20** (e.g., the wireless network adapter **22**) may include firmware, as described further below, that cause the components to make the transition to a common infrastructure wireless network **30** automatically and seamlessly, e.g., without user intervention. The earphone **10** may cache the received audio in a buffer or memory for a time period before playing the audio. The cached audio may be played after the connection over the ad hoc wireless network is lost to give the earphone **10** and the data source **20** time to connect via the infrastructure wireless network.

For example, as shown in FIG. **2**B, the infrastructure network may comprise an access point **32** that is in the range of both the data source **20** and the earphone **10**. The access point **32** may be an electronic hardware device that acts as a wireless access point for, and that is connected to, a wired and/or wireless data communication network **33**, such as a LAN or WAN, for example. The data source **20** and the earphone **10** may both communicate wirelessly with the access point **32** using the appropriate network data protocol (a Wi-Fi protocol, for example). The data source **20** and the earphone **10** may both transition automatically to an agreed-upon WLAN **30** that is in the range of both devices when they cannot communicate satisfactorily via the ad hoc wireless network **24**. A procedure for specifying an agreed-upon infrastructure wireless network **30** is described further below. Alternatively, the infrastructure wireless network **30** may have multiple access points **32***a-b*, as shown in FIG. **2**C. In such an embodiment, the data source **20** may communicate wirelessly with one access point **32***b* and the earphone **10** may communicate wirelessly with another access point **32***a* of the same infrastructure wireless network **30**. Again, the data source **20** and the earphone **10** may transition to an agreed-upon WLAN.

If there is no suitable common infrastructure wireless network over which the earphone **10** and the data source **20** can communicate, as shown in FIG. **2**D, the earphone **10** may transition to communicate with an access point **32***a* for an available (first) wireless network (e.g., WLAN) **30***a* that is in the range of the earphone **10**. In this mode, the earphone **10** may connect via the wireless network **30***a* to a network-enabled host server **40**. The host server **40** may be connected to the wireless network **30***a* via an electronic data communication network **42**, such as the Internet. In one mode, the host server **40** may transmit streaming digital audio via the networks **33***a*, **42** to the earphone **10**. In another mode, the host server **40** may transmit to the earphone **10** a network address, such as an Internet Protocol (IP) address, for a streaming digital audio content server **70** on the network **42**. Using the received IP address, the earphone **10** may connect to the streaming digital audio content server **70** via the networks **30***a*, **42** to receive and process digital audio from the streaming digital audio content server **70**.

The digital audio content server **70** may be, for example, an Internet radio station server. The digital audio content server **70** may stream digital audio over the network **42** (e.g., the Internet), which the earphone **10** may receive and process. In one embodiment, the streaming digital audio content server **70** may stream digital audio received by the streaming digital audio content server **70** from the data source **20**. For example, where the data source **20** is a wireless-capable device, such as a portable DAP, the data source **20** may connect to the streaming digital audio content server **70** via a wireless network **30***b* and the network **42**. Alternatively, where for example the data source **20** is non-wireless-capable device, such as a PC, the data source **20** may have a direct wired connection to the network **42**. After being authenticated by the streaming digital audio content server **70**, the data source **20** may stream digital audio to the streaming digital audio content server **70**, which may broadcast the received digital audio over the network **42** (e.g., the Internet). In such a manner, the user of the earphone **10** may listen to audio from the data source **20** even when (i) the earphone **10** and the data source **20** are not in communication via an ad hoc wireless network **24** and (ii) the earphone **10** and the data source **20** are not in communication via a common local infrastructure wireless network **30**.

FIG. **3** is a block diagram of the earphone **10** according to various embodiments of the present invention. In the illustrated embodiment, the earphone **10** comprises a transceiver circuit **100** and related peripheral components. As shown in FIG. **3**, the peripheral components of the earphone **10** may comprise a power source **102**, a microphone **104**, one or more acoustic transducers **106** (e.g., speakers), and an antenna **108**. The transceiver circuit **100** and some of the peripheral components (such as the power source **102** and the acoustic transducers **106**) may be housed within the body **12** of the earphone **10** (see FIG. **1**). Other peripheral components, such as the microphone **104** and the antenna **108** may be external to the body **12** of the earphone **10**. In addition, some of the peripheral components, such as the microphone **104**, are optional in various embodiments.

In various embodiments, the transceiver circuit **100** may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone **10**, which is advantageous if the earphone **10** is to be relatively small in size, such as an in-ear earphone (see FIGS. **1**A-**1**B for example). In alternative embodiments, however, the components of the transceiver circuit **100** could be realized with two or more discrete ICs or other components, such as separate ICs for the processors, memory, and RF (e.g., Wi-Fi) module, for example.

The power source **102** may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). In other embodiments, the power source **102** may comprise one or more ultracapacitors (sometimes referred to as supercapacitors) that are charged by a primary power source. In embodiments where the power source **102** comprises a rechargeable battery cell or an ultracapacitor, the battery cell or ultracapacitor, as the case may be, may be charged for use, for example, when the earphone **10** is connected to a docking station or computer. The docking station may be connected to or part of a computer device, such as a laptop computer or PC. In addition to charging the rechargeable

power source **102**, the docking station and/or computer may facilitate downloading of data to and/or from the earphone **10**. In other embodiments, the power source **102** may comprise capacitors passively charged with RF radiation, such as described in U.S. Pat. No. 7,027,311. The power source **102** may be coupled to a power source control module **103** of transceiver circuit **100** that controls and monitors the power source **102**.

The acoustic transducer(s) **106** may be the speaker element(s) for conveying the sound to the user of the earphone **10**. According to various embodiments, the earphone **10** may comprise one or more acoustic transducers **106**. For embodiments having more than one transducer, one transducer may be larger than the other transducer, and a crossover circuit (not shown) may transmit the higher frequencies to the smaller transducer and may transmit the lower frequencies to the larger transducer. More details regarding dual element earphones are provided in U.S. Pat. No. 5,333,206, assigned to Koss Corporation, which is incorporated herein by reference in its entirety.

The antenna **108** may receive and transmit the wireless signals from and to the wireless networks **24**, **30**. A RF (e.g., Wi-Fi) module **110** of the transceiver circuit **100** in communication with the antenna **108** may, among other things, modulate and demodulate the signals transmitted from and received by the antenna **108**. The RF module **110** communicates with a baseband processor **112**, which performs other functions necessary for the earphone **10** to communicate using the Wi-Fi (or other communication) protocol.

The baseband processor **112** may be in communication with a processor unit **114**, which may comprise a microprocessor **116** and a digital signal processor (DSP) **118**. The microprocessor **116** may control the various components of the transceiver circuit **100**. The DSP **114** may, for example, perform various sound quality enhancements to the digital audio received by the baseband processor **112**, including noise cancellation and sound equalization. The processor unit **114** may be in communication with a volatile memory unit **120** and a non-volatile memory unit **122**. A memory management unit **124** may control the processor unit's access to the memory units **120**, **122**. The volatile memory **122** may comprise, for example, a random access memory (RAM) circuit. The non-volatile memory unit **122** may comprise a read only memory (ROM) and/or flash memory circuits. The memory units **120**, **122** may store firmware that is executed by the processor unit **114**. Execution of the firmware by the processor unit **114** may provide various functionality for the earphone **10**, such as the automatic transition between wireless networks as described herein. The memory units **120**, **122** may also cache received digital audio.

A digital-to-analog converter (DAC) **125** may convert the digital audio from the processor unit **114** to analog form for coupling to the acoustic transducer(s) **106**. An I^2S interface **126** or other suitable serial or parallel bus interface may provide the interface between the processor unit **114** and the DAC **125**. An analog-to-digital converter (ADC) **128**, which also communicates with the I^2S interface **126**, may convert analog audio signals picked up by the microphone **104** for processing by the processor unit **114**.

The transceiver circuit **100** also may comprise a USB or other suitable interface **130** that allows the earphone **10** to be connected to an external device via a USB cable or other suitable link. As shown in FIG. **4**A, the external device may be a docking station **200** connected to a computer device **202**. Also, in various embodiments, the earphone **10** could be connected directly to the computer **202** without the docking station **200**. In addition, the external device may be a DAP **210**, as shown in FIG. **4**B. In that way, the earphone **10** could connect directly to a data source **20**, such as the DAP **210** or the computer **202**, through the USB port **130**. In addition, through the USB port **130**, the earphone **10** may connect to a PC **202** or docking station **202** to charge up the power source **102** and/or to get downloads (e.g., data or firmware).

According to various embodiments, the earphone **10** may have an associated web page that a user may access through the host server **40** (see FIG. **2**D) or some other server. An authenticated user could log onto the website from a client computing device **50** (e.g., laptop, PC, handheld computer device, etc., including the data source **20**) (see FIG. **2**D) to access the web page for the earphone **10** to set various profile values for the earphone **10**. For example, at the web site, the user could set various content features and filters, as well as adjust various sound control features, such as treble, bass, frequency settings, noise cancellation settings, etc. In addition, the user could set preferred streaming audio stations, such as preferred Internet radio stations or other streaming audio broadcasts. That way, instead of listening to streaming audio from the data source **20**, the user could listen to Internet radio stations or other streaming audio broadcasts received by the earphone **10**. In such an operating mode, the earphone user, via the web site, may prioritize a number of Internet radio stations or other broadcast sources (hosted by streaming digital audio content servers **70**). With reference to FIG. **7**, the host server **40** may send the IP address for the earphone user's desired (e.g., highest priority) Internet radio station to the earphone **10**. A button **11** on the earphone **10**, such as on the rotating dial **16** as shown in the examples of FIGS. **1**A and **1**B, may allow the user to cycle through the preset preferred Internet radio stations. That is, for example, when the user presses the button **11**, an electronic communication may be transmitted to the host server **40** via the wireless network **30**, and in response to receiving the communication, the host server **40** may send the IP address for the user's next highest rated Internet radio station via the network **42** to the earphone **10**. The earphone **10** may then connect to the streaming digital audio content server **70** for that Internet radio station using the IP address provided by the host server **40**. This process may be repeated, e.g., cycled through, for each preset Internet radio station configured by the user of the earphone **10**.

At the web site for the earphone **10** hosted on the host server **40**, in addition to establishing the identification of digital audio sources (e.g., IDs for the user's DAP or PC) and earphones, the user could set parental or other user controls. For example, the user could restrict certain Internet radio broadcasts based on content or parental ratings, etc. That is, for example, the user could configure a setting through the web site that prevents the host server **40** from sending an IP address for a streaming digital audio content server **70** that broadcasts explicit content based on a rating for the content. In addition, if a number of different earphones **10** are registered to the same user, the user could define separate controls for the different earphones **10** (as well as customize any other preferences or settings particular to the earphones **10**, including Internet radio stations, sound quality settings, etc. that would later be downloaded to the earphones **10**). In addition, in modes where the host server **40** streams audio to the earphone **10**, the host server **40** may log the files or content streamed to the various earphones **10**, and the user could view at the web site the

files or content that were played by the earphones **10**. In that way, the user could monitor the files played by the earphones **10**.

In addition, the host server **40** may provide a so-called eavesdropping function according to various embodiments. The eavesdropping service could be activated via the web site. When the service is activated, the host server **40** may transmit the content that it is delivering to a first earphone **10***a* to another, second earphone **10***b*, as shown in FIG. **8**. Alternatively, the host server **40** may transmit to the second earphone **10***b* the most recent IP address for a streaming digital audio content server **70** that was sent to the first earphone **10***a*. The second earphone **10***b* may then connect to the streaming digital audio content server **70** that the first earphone **10***a* is currently connected. That way, the user of the second earphone **10***b*, which may be a parent, for example, may directly monitor the content being received by the first earphone **10***a*, which may belong to a child of the parent.

This function also could be present in the earphones **10** themselves, allowing a parent (or other user) to join an ad-hoc wireless network and listen to what their child (or other listener) is hearing. For example, with reference to FIG. **10**, a first earphone **10***a* may receive wireless audio, such as from the data source **20** or some other source, such as the host server **40**. The first earphone **10***a* may be programmed with firmware to broadcast the received audio to a second earphone **10***b* via an ad hoc wireless network **24**. That way, the wearer of the second earphone **10***b* can monitor in real-time the content being played by the first earphone **10***a*.

At the web site, the user may also specify the identification number ("ID") of their earphone(s) **10**, and the host server **40** may translate the ID to the current internet protocol (IP) addresses for the earphone **10** and for the data source **20**. This allows the user to find his or her data source **20** even when it is behind a firewall or on a changing IP address. That way, the host server **40** can match the audio from the data source **20** to the appropriate earphone **10** based on the specified device ID. The user also could specify a number of different data sources **20**. For example, the user's DAP may have one specified IP address and the user's home (or work) computer may have another specified IP address. Via the web site hosted by the host server **40**, the user could specify or prioritize from which source (e.g., the user's DAP or computer) the earphone **10** is to receive content.

The host server **40** (or some other server) may also push firmware upgrades and/or data updates to the earphone **10** using the IP addresses of the earphone **10** via the networks **30**, **42**. In addition, a user could download the firmware upgrades and/or data updates from the host server **40** to the client computing device **202** (see FIG. **4**A) via the Internet, and then download the firmware upgrades and/or data updates to the earphone **10** when the earphone **10** is connected to the client computer device **202** (such as through a USB port and/or the docking station **200**).

Whether the downloads are transmitted wirelessly to the earphone **10** or via the client computing device **202** may depend on the current data rate of the earphone **10** and the quantity of data to be transmitted to the earphone **10**. For example, according to various embodiments, as shown in the process flow of FIG. **5**, the host server **40** may be programmed, at step **50**, to make a determination, based on the current data rate for the earphone **10** and the size of the update, whether the update should be pushed to the earphone **10** wirelessly (e.g., via the WLAN **30***a* in FIG. **2**D). If the update is too large and/or the current data rate is too low that the performance of the earphone **10** will be adversely affected, the host server **40** may refrain from pushing the update to the earphone **10** wirelessly and wait instead to download the update to the client computing device **202** at step **51**. Conversely, if the host server **40** determines that, given the size of the update and the current data rate for the earphone **10** that the performance of the earphone **10** will not be adversely affected, the host server **40** may transmit the update wirelessly to the earphone **10** at step **52**.

As mentioned above, the processor unit **114** of the speakerphones **14** may be programmed, via firmware stored in the memory **120**, **122**, to have the ability to transition automatically from the ad hoc wireless network **24** to an infrastructure wireless network **30** (such as a WLAN) when the quality of the signal on the ad hoc wireless network **24** degrades below a suitable threshold (such as when the data source **20** is out of range for an ad hoc wireless network). In that case, the earphone **10** and the data source **20** may connect to a common infrastructure wireless network (e.g., WLAN) (see, for example, FIGS. **2**B-**2**C). Through the web site for the earphone **10**, described above, the user could specify a priority of infrastructure wireless networks **30** for the data source **20** and the earphone **10** to connect to when the ad hoc wireless network **24** is not available. For example, the user could specify a WLAN servicing his/her residence first, a WLAN servicing his/her place of employment second, etc. During the time that the earphone **10** and the data source **20** are connected via the ad hoc wireless network **24**, the earphone **10** and the data source **20** may exchange data regarding which infrastructure networks are in range. When the earphone **10** and the data source **20** are no longer in range for the ad hoc wireless network **24** (that is, for example, the signals between the device degrade below an acceptable level), they may both transition automatically to the highest prioritized infrastructure wireless network whose signal strength is above a certain threshold level. That way, even though the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, the earphone **10** may still receive the streaming audio from the data source **20** via the infrastructure wireless network **30** (see FIGS. **2**B-**2**C).

When none of the preferred infrastructure networks is in range, the earphone **10** may connect automatically to the host server **40** via an available infrastructure wireless network **30** (see FIG. **2**D), e.g., the infrastructure wireless network **30** having the highest RSSI and to which the earphone **10** is authenticated to use. The host server **40**, as mentioned above, may transmit IP addresses to the earphone **10** for streaming digital audio content servers **70** or the host sever **40** may stream digital audio to the earphone **10** itself when in this communication mode.

FIG. **6** is a diagram of the process flow, according to one embodiment, implemented by the transceiver circuit **100** of the earphone **10**. The process shown in FIG. **6** may be implemented in part by the processor unit **114** executing firmware stored in a memory unit **120**, **122** of the transceiver circuit **100**. At step **61**, the earphone **10** may determine if it can communicate with the data source **20** via an ad hoc wireless network **24**. That is, the earphone **10** may determine if the strength of the wireless signals from the data source **20** exceed some minimum threshold. If so, the data source **20** and the earphone **10** may communicate wirelessly via the ad hoc wireless network **24** (see FIG. **2**A). While in this communication mode, at step **62**, the data source **20** and the earphone **10** also may exchange data regarding the local infrastructure wireless networks, if any, in the range of the data source **20** and the earphone **10**, respectively. For

example, the earphone **10** may transmit the ID of local infrastructure wireless networks **30** that the earphone **10** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. Similarly, the data source **20** may transmit the ID the local infrastructure wireless networks **30** that the data source **20** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. The earphone **10** may save this data in a memory unit **120**, **122**. Similarly, the data source **20** may store in memory the wireless networks that the earphone **10** is detected.

The data source **20** and the earphone **10** may continue to communicate via the ad hoc wireless network mode **24** until they are out of range (e.g., the signal strengths degrade below a minimum threshold level). If an ad hoc wireless network **24** is not available at block **61**, the transceiver circuit **100** and the data source **20** may execute a process, shown at block **63**, to connect to the user's highest prioritized infrastructure wireless network **30**. For example, of the infrastructure wireless networks whose signal strength exceeded the minimum threshold for both the earphone **10** and the data source **20** determined at step **62**, the earphone **10** and the data source **20** may both transition to the infrastructure wireless network **30** having the highest priority, as previously set by the user (seen FIGS. **2**B-**2**C, for example). For example, if the user's highest prioritized infrastructure wireless network **30** is not available, but the user's second highest prioritized infrastructure wireless network **30** is, the earphone **10** and the data source **20** may both transition automatically to the user's second highest prioritized infrastructure wireless network **30** at block **64**. As shown by the loop with block **65**, the earphone **10** and the data source **20** may continue to communicate via one of the user's prioritized infrastructure wireless networks **30** as long as the infrastructure wireless network **30** is available. If the infrastructure wireless network becomes unavailable, the process may return to block **61**.

If, however, no ad hoc wireless network and none of the user's prioritized infrastructure wireless networks are available, the earphone **10** may transition automatically to connect to the host server **40** at block **66** (see FIG. **2**D) using an available infrastructure wireless network **30**. At block **67**, the host server **40** may transmit an IP address to the earphone **10** for one of the streaming digital audio content servers **70**, and at block **68** the earphone **10** may connect to the streaming digital audio content server **70** using the received IP address. At step **69**, as long as the earphone **10** is connected to the streaming digital audio content server **70**, the earphone **10** may continue to communicate in this mode. However, if the earphone **10** loses its connection to the digital audio content server **70**, the process may return to block **61** in one embodiment. As mentioned above, at block **67**, instead of sending an IP address for a streaming digital audio content server **70**, the host server **40** may stream digital audio to the earphone **10**. The user, when configuring their earphone **10** preferences via the web site, may specify and/or prioritize whether the host server **40** is to send IP addresses for the streaming digital audio content servers **70** and/or whether the host server **40** is to stream audio to the earphone **10** itself.

In another embodiment, the earphone **10** may be programmed to transition automatically to the host server **40** when the earphone **10** and the data source **20** are not in communication via the ad hoc wireless network **24**. That is, in such an embodiment, the earphone **10** may not try to connect via a local infrastructure wireless network **30** with the data source **20**, but instead transition automatically to connect to the host server **40** (see FIG. **2**D).

In various embodiments, as shown in FIG. **1**B, the button **11** or other user selection device that allows the wearer of the earphone **10** to indicate approval and/or disapproval of songs or other audio files listened to by the wearer over an Internet radio station. The approval/disapproval rating, along with metadata for the song received by the earphone **10** with the streaming audio, may be transmitted from the transceiver circuit **100** of the earphone **10** back to the host server **40**, which may log the songs played as well as the ratings for the various songs/audio files. In addition to being able to view the logs at the website, the host server **40** (or some other server) may send an email or other electronic communication to the earphone user, at a user specified email address or other address, which the user might access from their client communication device **50** (see FIG. **2**D). The email or other electronic communication may contain a listing of the song/audio files for which the user gave approval ratings using the button **11** or other user selection device. Further, the email or other electronic communication may provide a URL link for a URL at which the user could download song/audio files that the user rated (presumably song/audio files for which the user gave an approval rating). In some instances, the user may be required to pay a fee to download the song/audio file.

The user song ratings also may be used by the host server **40** to determine the user's musical preferences and offer new music that the user might enjoy. More details about generating user play lists based on song ratings may be found in published U.S. patent applications Pub. No. 2006/0212444, Pub. No. 2006/0206487, and Pub. No. 2006/0212442, and U.S. Pat. No. 7,003,515, which are incorporated herein by reference in their entirety.

In addition or alternatively, the user could log onto a web site hosted by the host server **40** (or some other server) to view the approval/disapproval ratings that the user made via the button **11** on the earphone **10**. The web site may provide the user with the option of downloading the rated songs/audio files (for the host server **40** or some other server system) to their client computer device **50**. The user could then have their earphone **10** connect to their client computer device **50** as a data source **20** via an ad hoc wireless network **24** (see FIG. **2**A) or via an infrastructure wireless network (see FIGS. **2**B-**2**D) to listen to the downloaded songs. In addition, the user could download the song files from their client computer device **50** to their DAP and listen to the downloaded song files from their DAP by using their DAP as the data source **20** in a similar manner.

Another application of the headsets may be in vehicles equipped with Wi-Fi or other wireless network connectivity. Published PCT application WO 2007/136620, which is incorporated herein by reference, discloses a wireless router for providing a Wi-Fi or other local wireless network for a vehicle, such as a car, truck, boat, bus, etc. In a vehicle having a Wi-Fi or other local wireless network, the audio for other media systems in the vehicle could be broadcast over the vehicle's wireless network. For example, if the vehicle comprises a DVD player, the audio from the DVD system could be transmitted to the router and broadcast over the vehicle's network. Similarly, the audio from terrestrial radio stations, a CD player, or an audio cassette player could be broadcast over the vehicle's local wireless network. The vehicle's passengers, equipped with the earphones **10**, could cycle through the various audio broadcasts (including the broadcasts from the vehicle's media system as well as broadcasts from the host server **40**, for example) using a selection button **11** on the earphone **10**. The vehicle may also be equipped with a console or terminal, etc., through which

a passenger could mute all of the broadcasts for direct voice communications, for example.

As described above, the earphones **10** may also include a microphone **104**, as shown in the example of FIG. **9**. The headset **90** shown in FIG. **9** includes two earphones **10**, both of which may include a transceiver circuit **100** or only one of which may include the transceiver circuit, as discussed above. The microphone **104** could be used to broadcast communications from one earphone wearer to another earphone wearer. For example, one wearer could activate the microphone by pressing a button **92** on the headset **90**. The headset **90** may then transmit a communication via an ad hoc wireless network **24** or other wireless network to a nearby recipient (or recipients) equipped with a headset **90** with a transceiver circuit **100** in one or both of the earphones **10**. When such communication is detected by the recipient's headset **90**, the streaming audio received over the wireless network by the recipient's headset **90** may be muted, and the intercom channel may be routed to the transducer(s) of the recipient's headset **90** for playing for the recipient. This functionality may be valuable and useful where multiple wearers of the headsets **90** are in close proximity, such as on motorcycles, for example.

Another exemplary use of the earphones **10** is in a factory, warehouse, construction site, or other environment that might be noisy. Persons (e.g., workers) in the environment could use the earphones **10** for protection from the surrounding noise of the environment. From a console or terminal, a person (e.g., a supervisor) could select a particular recipient for a communication over the Wi-Fi network (or other local wireless network). The console or terminal may have buttons, dials, or switches, etc., for each user/recipient, or it could have one button or dial through which the sender could cycle through the possible recipients. In addition, the console or terminal could have a graphical user interface, through which the sender may select the desired recipient(s).

As mentioned above, the earphones **10** may comprise a USB port. In one embodiment, as shown in FIG. **11**, the user may use an adapter **150** that connects to the USB port of each earphone **10**. The adapter **150** may also have a plug connector **152**, such as a 3.5 mm jack, which allows the user to connect the adapter **150** to devices having a corresponding port for the connector **152**. When the earphones **10** detect a connection via their USB interfaces in such a manner, the Wi-Fi (or other wireless protocol) components may shut down or go into sleep mode, and the earphones **10** will route standard headphone level analog signals to the transducer(s) **106**. This may be convenient in environments where wireless communications are not permitted, such as airplanes, but where there is a convenient source of audio contact. For example, the adapter **150** could plug into a person's DAP. The DSP **118** of the earphone **10** may still be operational in such a non-wireless mode to provide noise cancellation and any applicable equalization.

The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect of the examples is/are intended to limit the scope of the described embodiments.

According to various embodiments, therefore, the present invention is directed to an earphone **10** that comprises a body **12**, where the body **12** comprises: (i) at least one acoustic transducer **106** for converting an electrical signal to sound; (ii) an antenna **108**; and (iii) a transceiver circuit **100** in communication with the at least one acoustic transducer **106** and the antenna **108**. The transceiver circuit **100** is for receiving and transmitting wireless signals via the antenna **108**, and the transceiver circuit **100** is for outputting the electrical signal to the at least one acoustic transducer **106**. The wireless transceiver circuit also comprises firmware, which when executed by the transceiver circuit, causes the transceiver circuit to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the earphone **10** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

According to various implementations, the data source may comprise a portable digital audio player, such as an MP3 player, iPod, or laptop computer, or a nonportable digital audio player, such as a personal computer. In addition, the transceiver circuit **100** may comprise: (i) a wireless communication module **110** (such as a Wi-Fi or other wireless communication protocol module); (ii) a processor unit **114** in communication with the wireless communication module **110**; (iii) a non-volatile memory unit **122** in communication with the processor unit **114**; and (iv) a volatile memory **120** unit in communication with the processor unit **114**. The infrastructure wireless network may comprise a WLAN. The transceiver circuit **100** may receive digital audio from the data source **20** via the infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transition automatically to a pre-set infrastructure wireless network **30** that the data source **20** transitions to when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24** and when the pre-set infrastructure wireless network **30** is in range of both the earphone **10** and the data source **20**. In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transmit data via the ad hoc wireless network **24** to the data source **20** regarding one or more infrastructure wireless networks **30** detected by the transceiver circuit **100** when the earphone **10** and the data source **20** are communicating via the ad hoc wireless network **24**.

In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to connect to a host server **40** via an available infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The earphone **10** may receive streaming digital audio from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may receive a first network address for a first streaming digital audio content server **70** from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may comprise a user control, such as button **11**, dial, pressure switch, or other type of user control, that, when activated, causes the earphone **10** to transmit an electronic request via the infrastructure wireless network **30** to the host server **40** for a second network address for a second streaming digital audio content server **70**.

In other embodiments, the present invention is directed to a system that comprises: (i) a data source **20** for wirelessly transmitting streaming digital audio; and (ii) a wireless earphone **10** that is in wireless communication with the data

source **20**. In yet other embodiments, the present invention is directed to a communication system that comprises: (i) a host server **40**; (ii) a first streaming digital audio content server **70** that is connected to the host server **40** via a data network **42**; and (iii) a wireless earphone **10** that is in communication with the host server **40** via a wireless network **30**. The host server **40** is programmed to transmit to the earphone **10** a first network address for the first streaming digital audio content server **70** on the data network **42**. The host server **40** and the streaming digital audio content server(s) **70** each may comprise one or more processor circuits and one or more memory circuits (e.g., ROM circuits and/or RAM circuits).

In yet another embodiment, the present invention is directed to a headset that comprises: (i) a first earphone **10***a* that comprises one or more acoustic transducers **10***b* for converting a first electrical signal to sound; and (ii) a second earphone **10***b*, connected to the first earphone **10***a*, wherein the second earphone **10***b* comprises one or more acoustic transducers **10***b* for converting a second electrical signal to sound. In one embodiment, the first earphone **10***a* comprises: (i) a first antenna **108**; and (ii) a first transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the first earphone **10***a* and in communication with the first antenna **108**. The first transceiver circuit **100** is for receiving and transmitting wireless signals via the first antenna **108**, and for outputting the first electrical signal to the one or more acoustic transducers **10***b* of the first earphone **10***a*. The first transceiver circuit **100** also may comprise firmware, which when executed by the first transceiver circuit **100**, causes the first transceiver circuit **100** to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the first earphone **10***a* via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the first earphone **10***a* via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

In various implementations, the headset further may comprise a head band **19** that is connected to the first and second earphones **10**. In addition, the headset **19** further may comprise a microphone **104** having an output connected to the first transceiver circuit **100**. In one embodiment, the first transceiver circuit **100** is for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10***b*. In another embodiment, the second earphone **10***b* comprises: (i) a second antenna **108**; and (ii) a second transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the second earphone **10***b* and in communication with the second antenna **108**. The second transceiver circuit **100** is for receiving and transmitting wireless signals via the second antenna **108**, and for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10***b*. The second transceiver circuit **100** may comprise firmware, which when executed by the second transceiver circuit **100**, causes the second transceiver circuit **100** to: (i) receive digital audio wirelessly from the data source **20** via the ad hoc wireless network **24** when the data source **20** is in wireless communication range with the second earphone **10***b* via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the second earphone **10***b* via the ad hoc wireless network **24**, transition automatically to receive digital audio via the infrastructure wireless network **30**.

In addition, according to various embodiments, the first earphone **10***a* may comprise a first data port and the second earphone **10***b* may comprise a second data port. In addition, the headset may further comprise an adapter or dongle **150** connected to the first data port of the first earphone **10***a* and to the second data port of the second earphone **10***b*, wherein the adapter **150** comprises an output plug connector **152** for connecting to a remote device.

In addition, according to other embodiments, the present invention is directed to a method that comprises the steps of: (i) receiving, by a wireless earphone, via an ad hoc wireless network, digital audio from a data source when the data source is in wireless communication with the earphone via the ad hoc wireless network; (ii) converting, by the wireless earphone, the digital audio to sound; and (iii) when the data source is not in wireless communication with the earphone, transitioning automatically, by the earphone, to receive digital audio via an infrastructure wireless network.

In various implementations, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprises transitioning automatically to receive digital audio from the data source via an infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. In addition, the method may further comprise the step of receiving by the wireless earphone from the data source via the ad hoc wireless network data regarding one or more infrastructure wireless networks detected by data source when the earphone and the data source are communicating via the ad hoc wireless network.

In addition, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network comprises may transitioning automatically to receive digital audio from a host sever via the infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. Additionally, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise: (i) receiving, by the wireless earphone via the infrastructure wireless network, from a host server connected to the infrastructure wireless network, a network address for a streaming digital audio content server; and (ii) connecting, by the wireless earphone, to the streaming digital audio content server using the network address received from the host server.

It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments, while eliminating, for purposes of clarity, other elements. For example, certain operating system details for the various computer-related devices and systems are not described herein. Those of ordinary skill in the art will recognize, however, that these and other elements may be desirable in a typical processor or computer system. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

In general, it will be apparent to one of ordinary skill in the art that at least some of the embodiments described herein may be implemented in many different embodiments of software, firmware and/or hardware. The software and firmware code may be executed by a processor or any other similar computing device. The software code or specialized control hardware that may be used to implement embodiments is not limiting. For example, embodiments described herein may be implemented in computer software using any

suitable computer software language type. Such software may be stored on any type of suitable computer-readable medium or media, such as, for example, a magnetic or optical storage medium. The operation and behavior of the embodiments may be described without specific reference to specific software code or specialized hardware components. The absence of such specific references is feasible, because it is clearly understood that artisans of ordinary skill would be able to design software and control hardware to implement the embodiments based on the present description with no more than reasonable effort and without undue experimentation.

Moreover, the processes associated with the present embodiments may be executed by programmable equipment, such as computers or computer systems and/or processors. Software that may cause programmable equipment to execute processes may be stored in any storage device, such as, for example, a computer system (nonvolatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, at least some of the processes may be programmed when the computer system is manufactured or stored on various types of computer-readable media.

A "computer," "computer system," "host," "host server," "server," or "processor" may be, for example and without limitation, a processor, microcomputer, minicomputer, server, mainframe, laptop, personal data assistant (PDA), wireless e-mail device, cellular phone, pager, processor, fax machine, scanner, or any other programmable device configured to transmit and/or receive data over a network. Such components may comprise: one or more processor circuits; and one more memory circuits, including ROM circuits and RAM circuits. Computer systems and computer-based devices disclosed herein may include memory for storing certain software applications used in obtaining, processing, and communicating information. It can be appreciated that such memory may be internal or external with respect to operation of the disclosed embodiments. The memory may also include any means for storing software, including a hard disk, an optical disk, floppy disk, ROM (read only memory), RAM (random access memory), PROM (programmable ROM), EEPROM (electrically erasable PROM) and/or other computer-readable media.

In various embodiments disclosed herein, a single component may be replaced by multiple components and multiple components may be replaced by a single component to perform a given function or functions. Except where such substitution would not be operative, such substitution is within the intended scope of the embodiments. Any servers described herein, such as the host server **40**, for example, may be replaced by a "server farm" or other grouping of networked servers (such as server blades) that are located and configured for cooperative functions. It can be appreciated that a server farm may serve to distribute workload between/among individual components of the farm and may expedite computing processes by harnessing the collective and cooperative power of multiple servers. Such server farms may employ load-balancing software that accomplishes tasks such as, for example, tracking demand for processing power from different machines, prioritizing and scheduling tasks based on network demand and/or providing backup contingency in the event of component failure or reduction in operability.

While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

What is claimed is:

1. Headphones comprising:

a pair of first and second wireless earphones to be worn simultaneously by a user, wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected, wherein each of the first and second earphones comprises:

a body portion;

an earbud extending from the body portion that is inserted into an ear of the user when worn by the user;

a curved hanger bar connected to the body portion, wherein the curved hanger bar comprises a portion that rests upon an upper external curvature of an ear of the user behind an upper portion of an auricula of the ear of the user;

a wireless communication circuit for receiving and transmitting wireless signals;

a processor circuit connected to the wireless communication circuit;

at least one acoustic transducer for producing audible sound from the earbud;

a microphone for picking up utterances of a user of the headphones;

an antenna connected to the wireless communication circuit; and

a rechargeable power source; and

a docking station for holding at least the first wireless earphone, wherein the docking station comprises a power cable for connecting to an external device to power the docking station, and wherein the docking station is for charging at least the first wireless earphone when the first wireless earphone is placed in the docking station.

2. The headphones of claim **1**, wherein:

the wireless communication circuits are for receiving, wirelessly, streaming audio content;

the at least one acoustic transducers are for playing the streaming audio content; and

each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

3. The headphones of claim **1**, wherein the processor circuit for the first earphone is for, upon activation of a user control of the headphones, initiating transmission of a request to a remote network server that is remote from the headphones.

4. The headphones of claim **3**, wherein the processor circuit of the first earphone is further for receiving a response to the request.

5. The headphones of claim **1**, wherein the processor circuits are configured to transition from playing streaming audio content received wirelessly from a first digital audio source via a first communication link to playing streaming audio content received wirelessly from a second digital audio source via a second communication link based on, at least in part, a signal strength for the second wireless communication link.

6. The headphones of claim **5**, wherein:

the wireless communication circuits are for receiving, wirelessly, streaming audio content;

the at least one acoustic transducers are for playing the streaming audio content; and

each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

7. The headphones of claim **6**, wherein the processor circuit of each of the first and second earphones comprises:

a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone; and

a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

8. The headphones of claim **7**, wherein the rechargeable power source comprises a passive, wireless rechargeable power source.

9. The headphones of claim **1**, the processor circuits of the headphones are configured to receive firmware upgrades transmitted from a remote network server.

10. The headphones of claim **9**, wherein the headphone are configured to receive the firmware upgrades wirelessly.

11. The headphones of claim **10**, wherein the processor circuits are configured to transition from playing streaming audio content received wirelessly from a first digital audio source via a first communication link to playing streaming audio content received wirelessly from a second digital audio source via a second communication link based on, at least in part, a signal strength for the second wireless communication link.

12. The headphones of claim **11**, wherein the processor circuit of each of the first and second earphones comprises:

a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone; and

a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

13. The headphones of claim **12**, wherein:

the wireless communication circuits are for receiving, wirelessly, streaming audio content;

the at least one acoustic transducers are for playing the streaming audio content; and

each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

14. The headphones of claim **10**, wherein:

the wireless communication circuits are for receiving, wirelessly, streaming audio content;

the at least one acoustic transducers are for playing the streaming audio content; and

each of the first and second earphones comprises a buffer for caching the streaming audio content prior to being played by the at least one acoustic transducer.

15. The headphones of claim **1**, wherein the processor circuit of the first earphone is configured to:

process audible utterances by the user picked by the microphone in response to activation of the microphone by the user; and

transmit a communication based on the audible utterances via the Bluetooth wireless communication links.

16. The headphones of claim **1**, wherein the rechargeable power source comprises wirelessly chargeable circuit components.

17. The headphones of claim **1**, wherein the rechargeable power source comprises a passive, wireless rechargeable power source.

18. The headphones of claim **1**, wherein the processor circuit of each of the first and second earphones comprises:

a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone; and

a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

* * * * *

(12) **United States Patent**
Koss et al.

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(45) **Date of Patent: *Nov. 26, 2019**

(54) **SYSTEM WITH WIRELESS EARPHONES**

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H04R 1/10 (2006.01)
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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,784,685 A 7/1998 Stanford et al.
6,006,115 A 12/1999 Wingate
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2004-320597 11/2004
JP 2008-67258 A 3/2008
(Continued)

OTHER PUBLICATIONS

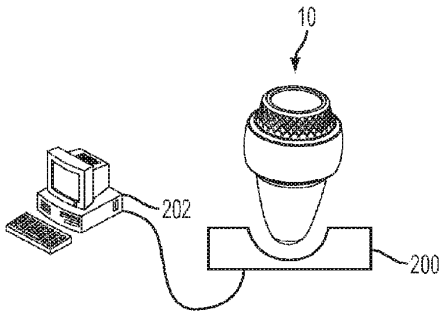
Supplementary European Search Report for European Application No. 09731146.8 dated Jun. 10, 2011, 7 pages.
(Continued)

Primary Examiner — Kiet M Doan
(74) *Attorney, Agent, or Firm* — K&L Gates LLP

(57) **ABSTRACT**

Apparatus comprises adapter and speaker system. Adapter is configured to plug into port of personal digital audio player. Speaker system is in communication with adapter, and comprises multiple acoustic transducers, programmable processor circuit, and wireless communication circuit. In first operational mode, processor circuit receives, via adapter, and processes digital audio content from personal digital audio player into which adapter is plugged, and the multiple acoustic transducers output the received audio content from the personal digital audio player. In second operational mode, wireless communication circuit receives digital audio content from a remote digital audio source over a wireless network, processor circuit processes the digital audio content received from remote digital audio source, and the multiple acoustic transducers output the audio content received from the remote digital audio source.

20 Claims, 16 Drawing Sheets



Related U.S. Application Data

No. 16/182,927, filed on Nov. 7, 2018, now Pat. No. 10,368,155, which is a continuation of application No. 15/962,305, filed on Apr. 25, 2018, now Pat. No. 10,206,025, which is a continuation of application No. 15/650,362, filed on Jul. 14, 2017, now Pat. No. 9,986,325, which is a continuation of application No. 15/293,785, filed on Oct. 14, 2016, now Pat. No. 9,729,959, which is a continuation of application No. 15/082,040, filed on Mar. 28, 2016, now Pat. No. 9,497,535, which is a continuation of application No. 14/695,696, filed on Apr. 24, 2015, now Pat. No. 9,438,987, which is a continuation of application No. 13/609,409, filed on Sep. 11, 2012, now Pat. No. 9,049,502, which is a continuation of application No. 13/459,291, filed on Apr. 30, 2012, now Pat. No. 8,571,544, which is a continuation of application No. 12/936,488, filed as application No. PCT/US2009/039754 on Apr. 7, 2009, now Pat. No. 8,190,203.

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H04R 1/02	(2006.01)
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H04H 20/95	(2008.01)
H03K 17/96	(2006.01)
H04W 4/80	(2018.01)
H04W 84/12	(2009.01)
H04W 84/18	(2009.01)
H04R 25/00	(2006.01)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,389,463	B2	5/2002	Bolas	
6,671,494	B1	12/2003	James	
6,674,864	B1	1/2004	Kitamura	
6,792,091	B2	9/2004	Lemchen et al.	
6,937,712	B2	8/2005	Lemchen et al.	
7,003,515	B1	2/2006	Glaser	
7,027,311	B2	4/2006	Vanderelli	
7,095,455	B2	8/2006	Jordan	
7,099,370	B2	8/2006	Takahashi	
7,120,388	B2	10/2006	Hall	
7,139,585	B2	11/2006	Hachimura et al.	
7,266,390	B2	9/2007	Mathews	
7,337,027	B2	2/2008	Nishiguchi et al.	
7,467,021	B2	12/2008	Yuen	
7,512,414	B2	3/2009	Jannard et al.	
7,599,679	B2	10/2009	Awiszus	
7,650,168	B2	1/2010	Bailey	
7,680,490	B2	3/2010	Bloebaum et al.	
7,697,899	B2	4/2010	Rofougaran	
7,734,055	B2	6/2010	Chiloyan	
7,764,775	B2	7/2010	Tarkoff et al.	
7,805,210	B2	9/2010	Cucos	
7,861,312	B2	12/2010	Lee et al.	
7,962,482	B2	6/2011	Handman	
8,023,663	B2	9/2011	Goldberg	
8,027,638	B2	9/2011	Sanguino	
8,055,007	B2	11/2011	Kim	
8,073,137	B2	12/2011	Weinans et al.	
8,086,281	B2	12/2011	Rabu et al.	
8,102,836	B2	1/2012	Jerlhagen	
8,190,203	B2	5/2012	Pelland et al.	
8,295,516	B2	10/2012	Kondo et al.	
8,335,312	B2	12/2012	Gerhardt et al.	
8,401,202	B2	3/2013	Brooking	
8,478,880	B2	7/2013	Finkelstein et al.	
8,483,755	B2	7/2013	Kumar	
8,553,865	B2	10/2013	Menard et al.	
8,571,544	B2	10/2013	Pelland et al.	
8,655,420	B1	2/2014	Pelland et al.	
8,792,945	B2	7/2014	Russell et al.	
9,049,502	B2	6/2015	Pelland et al.	
9,497,535	B1	11/2016	Koss et al.	
9,729,959	B2	8/2017	Koss et al.	
2003/0182003	A1	9/2003	Takashima	
2004/0107271	A1	6/2004	Ahn et al.	
2005/0064853	A1	3/2005	Radpour	
2005/0136839	A1	6/2005	Seshadri et al.	
2005/0198233	A1	9/2005	Manchester	
2006/0083388	A1	4/2006	Rothschild	
2006/0206487	A1	9/2006	Harada	
2006/0212442	A1	9/2006	Conrad	
2006/0212444	A1	9/2006	Handman et al.	
2006/0238878	A1	10/2006	Miyake	
2006/0268830	A1	11/2006	Evans	
2007/0008984	A1	1/2007	Phillips	
2007/0037615	A1*	2/2007	Glezerman	H04M 1/6066 455/575.2
2007/0049198	A1	3/2007	Walsh et al.	
2007/0053543	A1	3/2007	Lee	
2007/0136446	A1	6/2007	Rezvani et al.	
2007/0165875	A1	7/2007	Rezvani	
2007/0253603	A1	11/2007	Kimura et al.	
2007/0297618	A1	12/2007	Nurmi et al.	
2008/0019557	A1	1/2008	Bevirt et al.	
2008/0031470	A1	2/2008	Angelhag	
2008/0062939	A1	3/2008	Van Horn	
2008/0076489	A1*	3/2008	Rosener	H04M 1/6066 455/575.2
2008/0194209	A1	8/2008	Haupt et al.	
2008/0215777	A1	9/2008	Richenstein et al.	
2008/0226094	A1	9/2008	Rutschman	
2008/0242312	A1	10/2008	Paulson et al.	
2008/0298606	A1*	12/2008	Johnson	H04R 1/1091 381/74
2008/0311852	A1	12/2008	Hansen et al.	
2009/0029743	A9	1/2009	Lair et al.	
2009/0116678	A1	5/2009	Bevirt et al.	
2009/0129605	A1	5/2009	Camp et al.	
2009/0248178	A1	10/2009	Paulson et al.	
2010/0290642	A1	11/2010	Haseagawa	
2011/0275323	A1	11/2011	Goldman et al.	
2013/0039510	A1	2/2013	Pelland et al.	
2013/0099507	A1	4/2013	Moriya et al.	
2015/0237439	A1	8/2015	Koss et al.	
2017/0318378	A1	11/2017	Koss et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0249240	A1	8/2018	Koss et al.
2019/0075390	A1	3/2019	Koss et al.
2019/0238970	A1	8/2019	Koss et al.

FOREIGN PATENT DOCUMENTS

WO	WO 2006/047724	A2	5/2006
WO	WO 2007/136620	A2	11/2007
WO	WO 2007/139578	A1	12/2007
WO	WO 2008/033478	A1	3/2008
WO	WO 2008/054985	A2	5/2008
WO	WO 2009/086555	A1	7/2009

OTHER PUBLICATIONS

International Search Report for International Application No. PCT/US09/39754 dated Jun. 11, 2009, 2 pages.
International Preliminary Examination Report for International Application No. PCT/US09/39754 dated Oct. 28, 2010, 8 pages.
Written Opinion of the International Searching Authority for International Application No. PCT/US09/39754 dated Jun. 11, 2009, 5 pages.
IT Review, "LTB 802.11 WiFi Headphones", http://itreview.belproject.com/item/1536 accessed on Mar. 13, 2008 (4 pages).

* cited by examiner

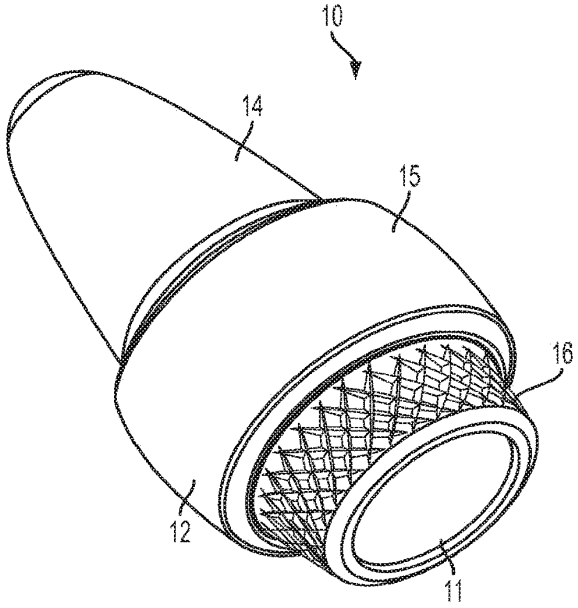

FIG. 1A

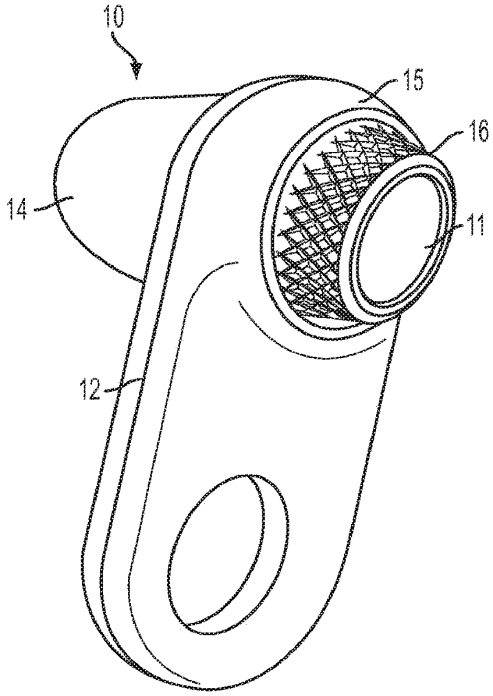

FIG. 1B

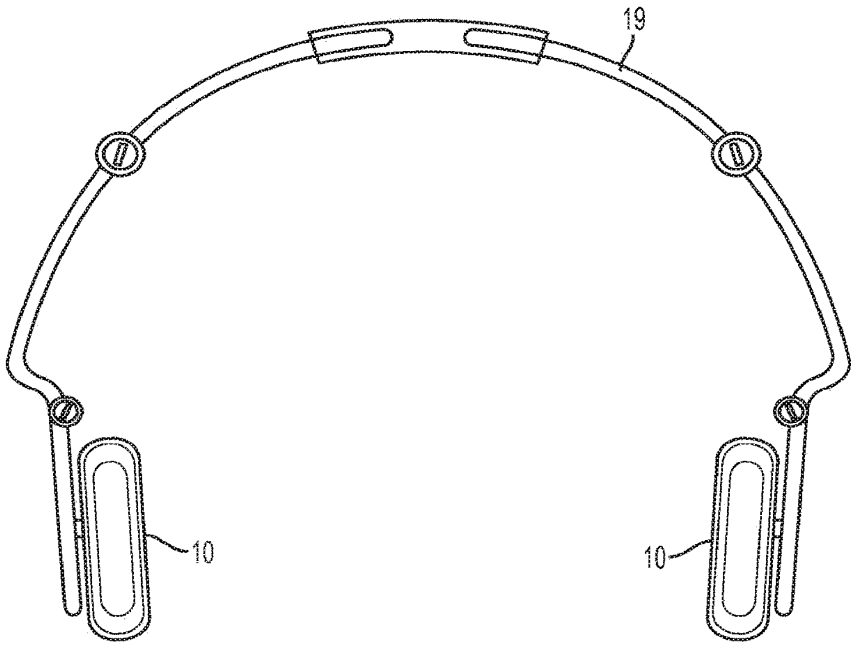

FIG. 1C

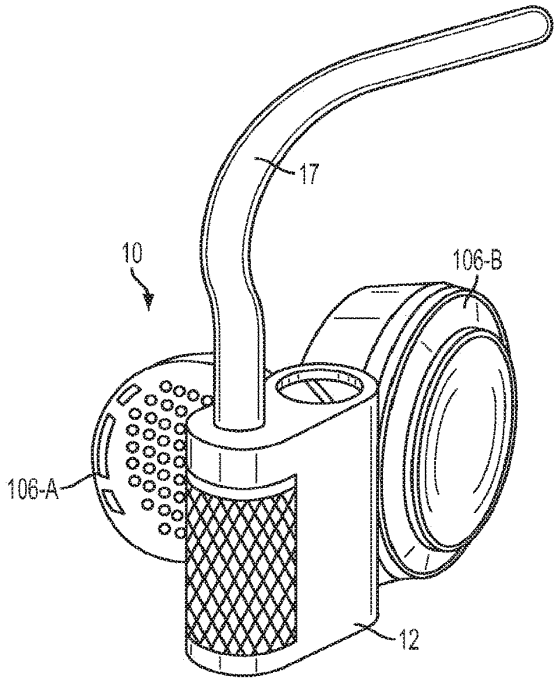

FIG. 1D

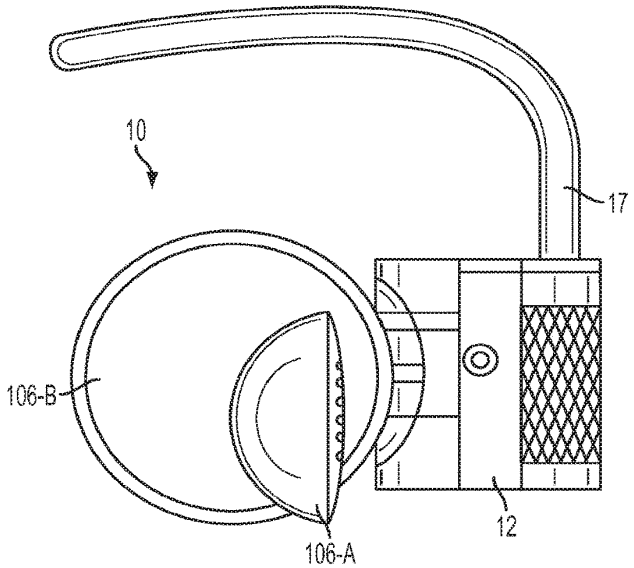

FIG. 1E

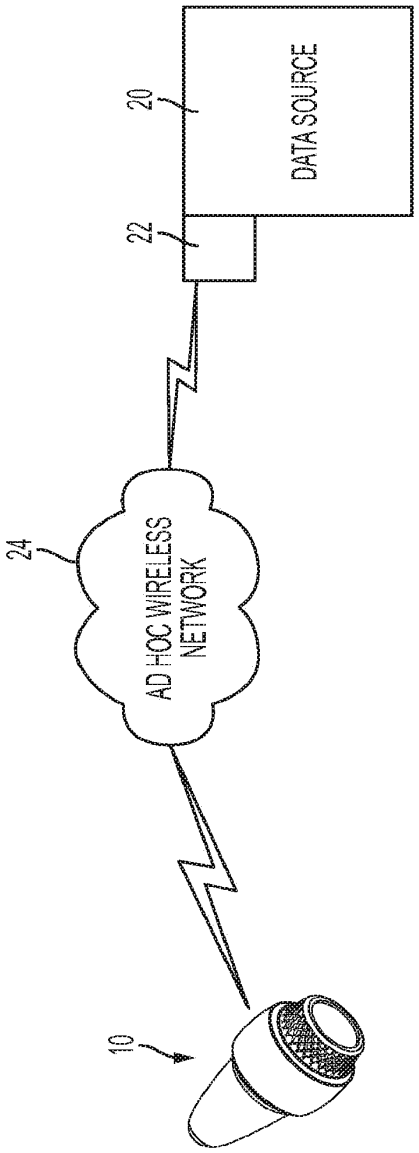

FIG. 2A

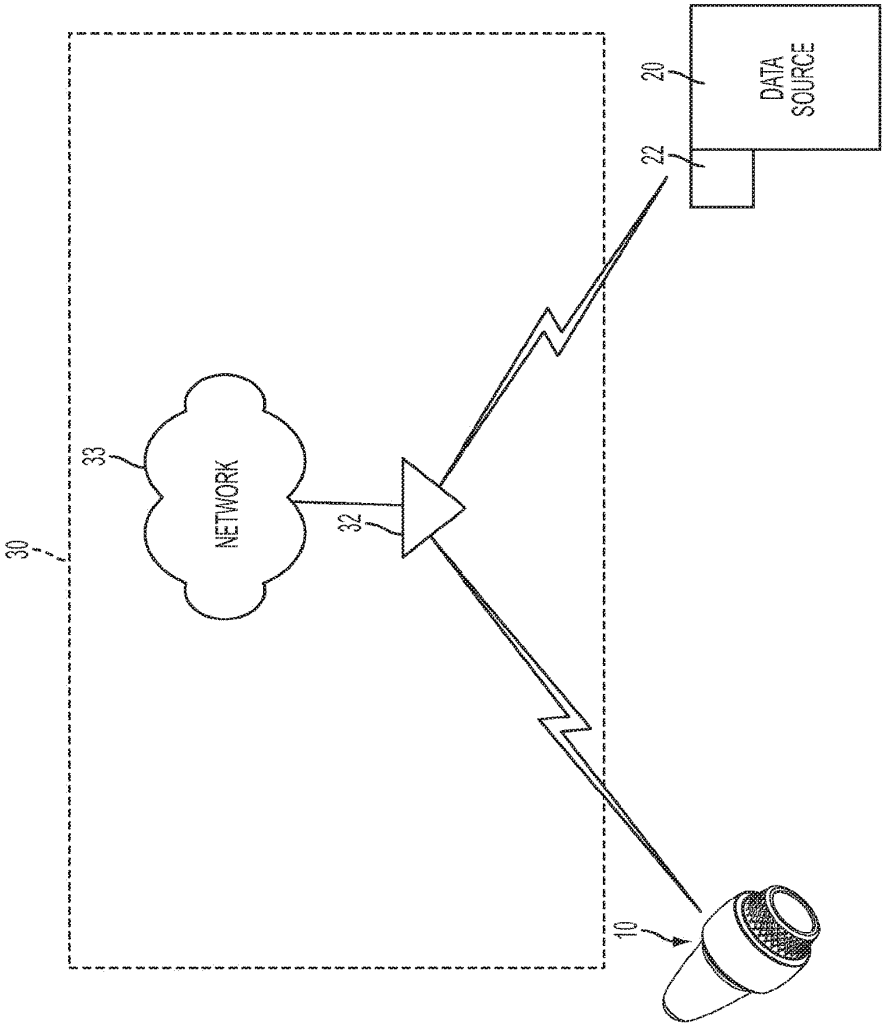

FIG. 2B

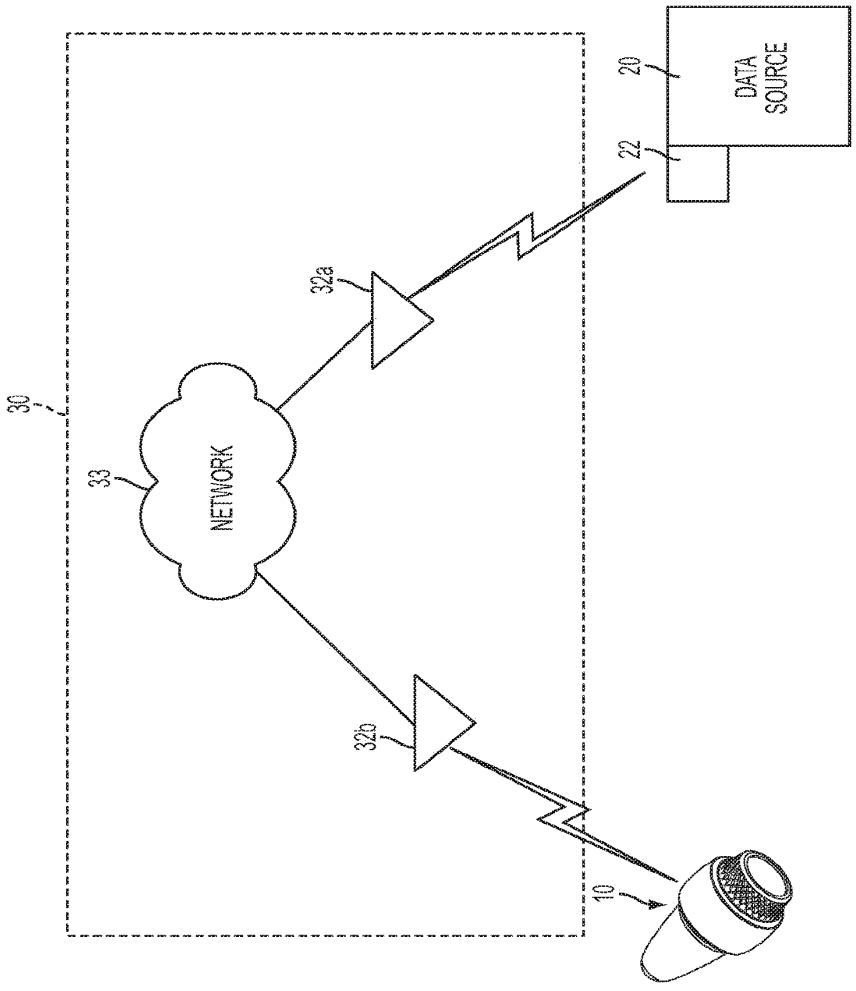

FIG. 2C

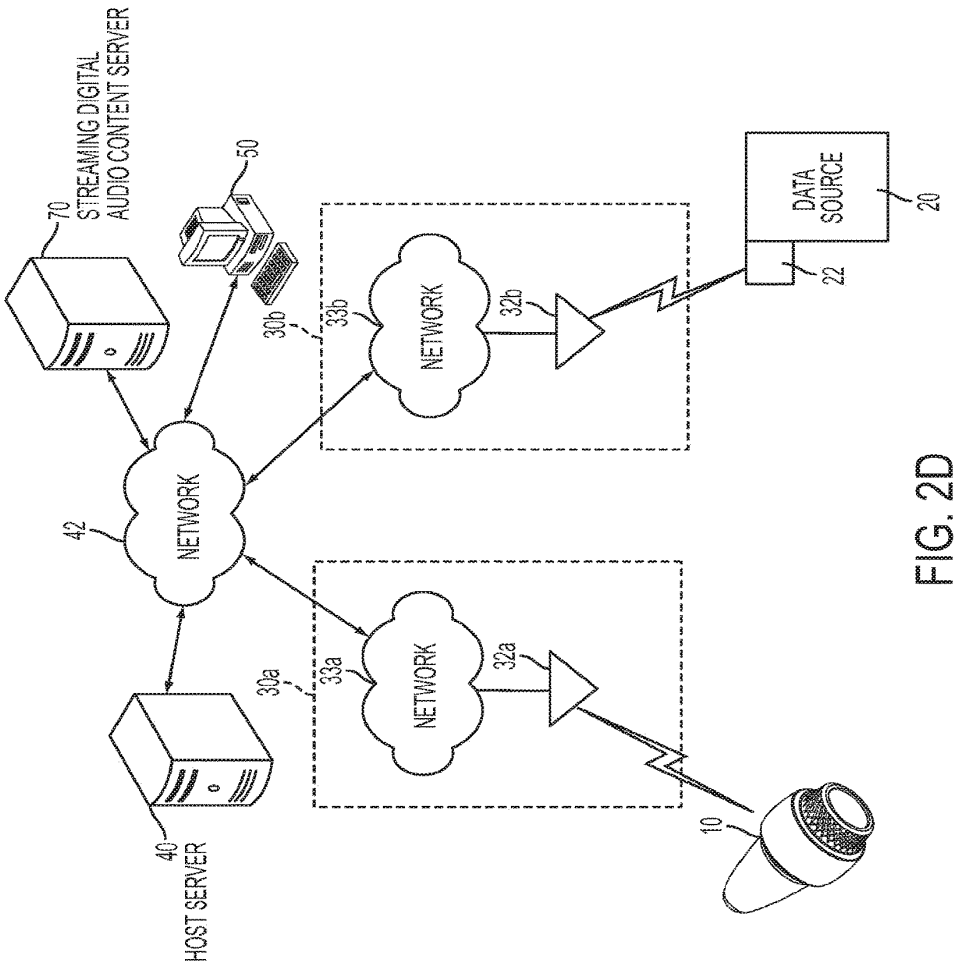
STREAMING DIGITAL AUDIO CONTENT SERVER
70
50
30b
33b
NETWORK
32b
DATA SOURCE
20
22
42
NETWORK
30a
33a
NETWORK
32a
10
40
HOST SERVER

FIG. 2D

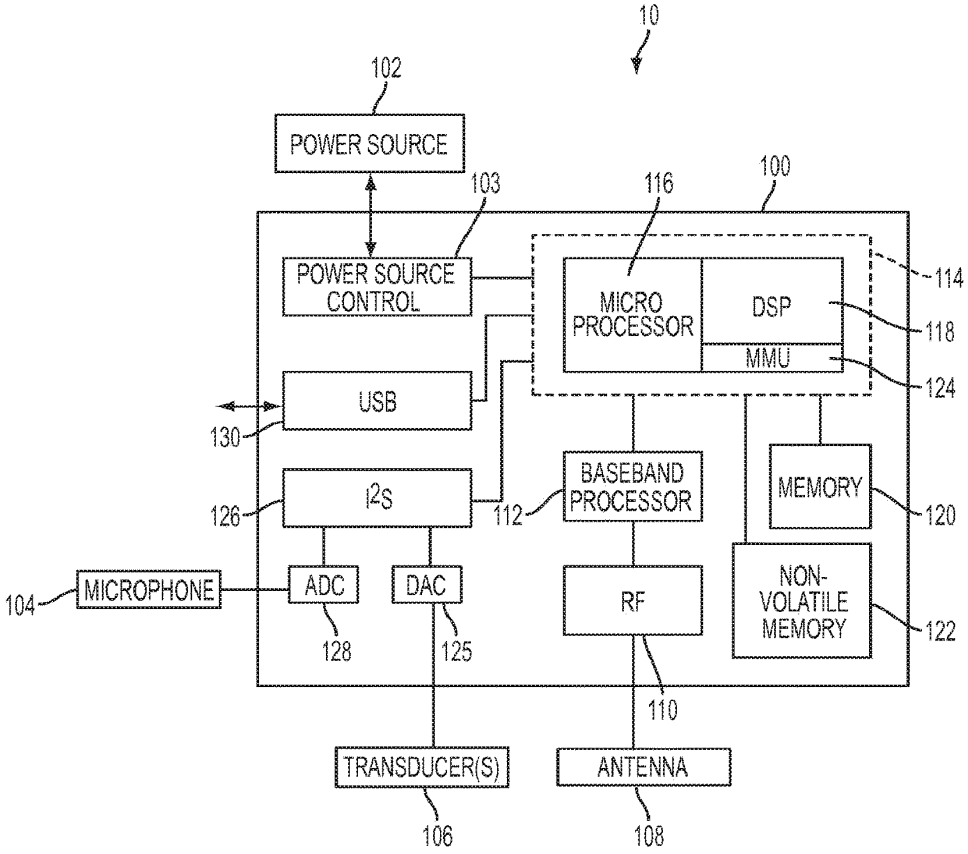
10
102
POWER SOURCE
103
116
100
POWER SOURCE CONTROL
MICRO PROCESSOR
DSP
MMU
114
118
124
USB
130
BASEBAND PROCESSOR
MEMORY
120
126
I2S
112
104
MICROPHONE
ADC
DAC
RF
NON-VOLATILE MEMORY
122
128
125
110
TRANSDUCER(S)
ANTENNA
106
108

FIG. 3

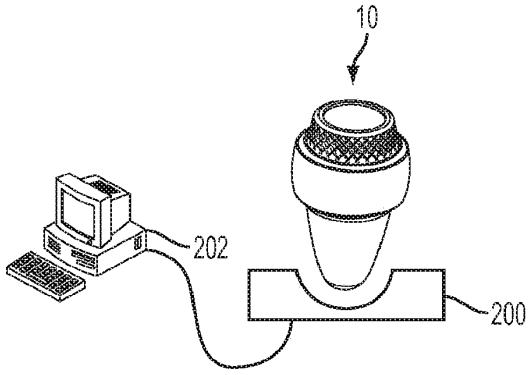

FIG. 4A

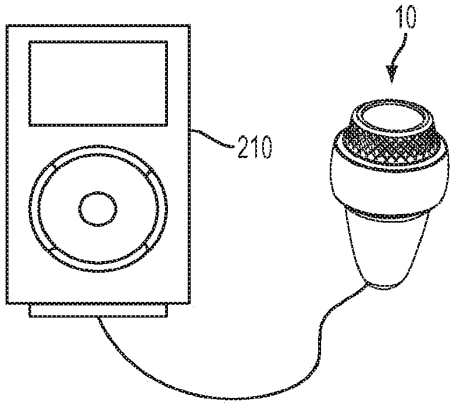

FIG. 4B

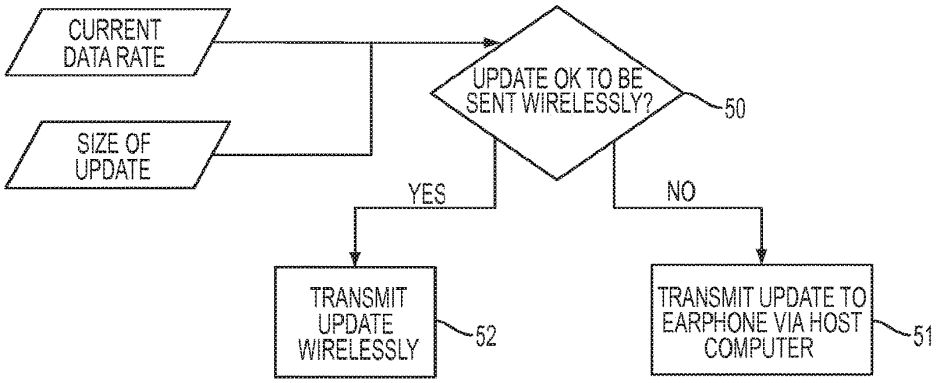
CURRENT DATA RATE
SIZE OF UPDATE
UPDATE OK TO BE SENT WIRELESSLY?
50
YES
NO
TRANSMIT UPDATE WIRELESSLY
52
TRANSMIT UPDATE TO EARPHONE VIA HOST COMPUTER
51

FIG. 5

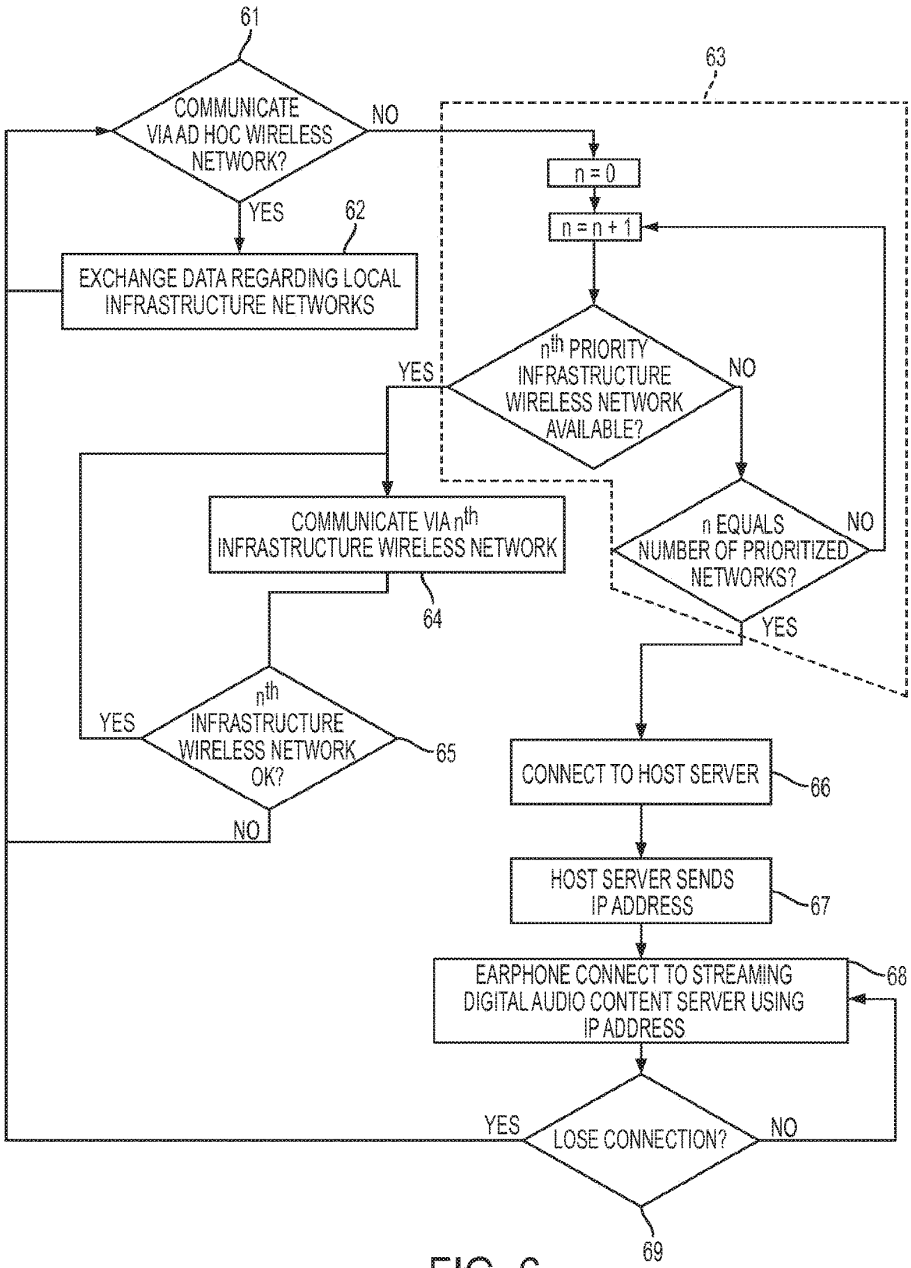
61
COMMUNICATE VIA AD HOC WIRELESS NETWORK?
NO
YES
62
EXCHANGE DATA REGARDING LOCAL INFRASTRUCTURE NETWORKS
63
n = 0
n = n + 1
nth PRIORITY INFRASTRUCTURE WIRELESS NETWORK AVAILABLE?
YES
NO
COMMUNICATE VIA nth INFRASTRUCTURE WIRELESS NETWORK
64
n EQUALS NUMBER OF PRIORITIZED NETWORKS?
NO
YES
nth INFRASTRUCTURE WIRELESS NETWORK OK?
YES
65
NO
CONNECT TO HOST SERVER
66
HOST SERVER SENDS IP ADDRESS
67
EARPHONE CONNECT TO STREAMING DIGITAL AUDIO CONTENT SERVER USING IP ADDRESS
68
YES
LOSE CONNECTION?
NO
69

FIG. 6

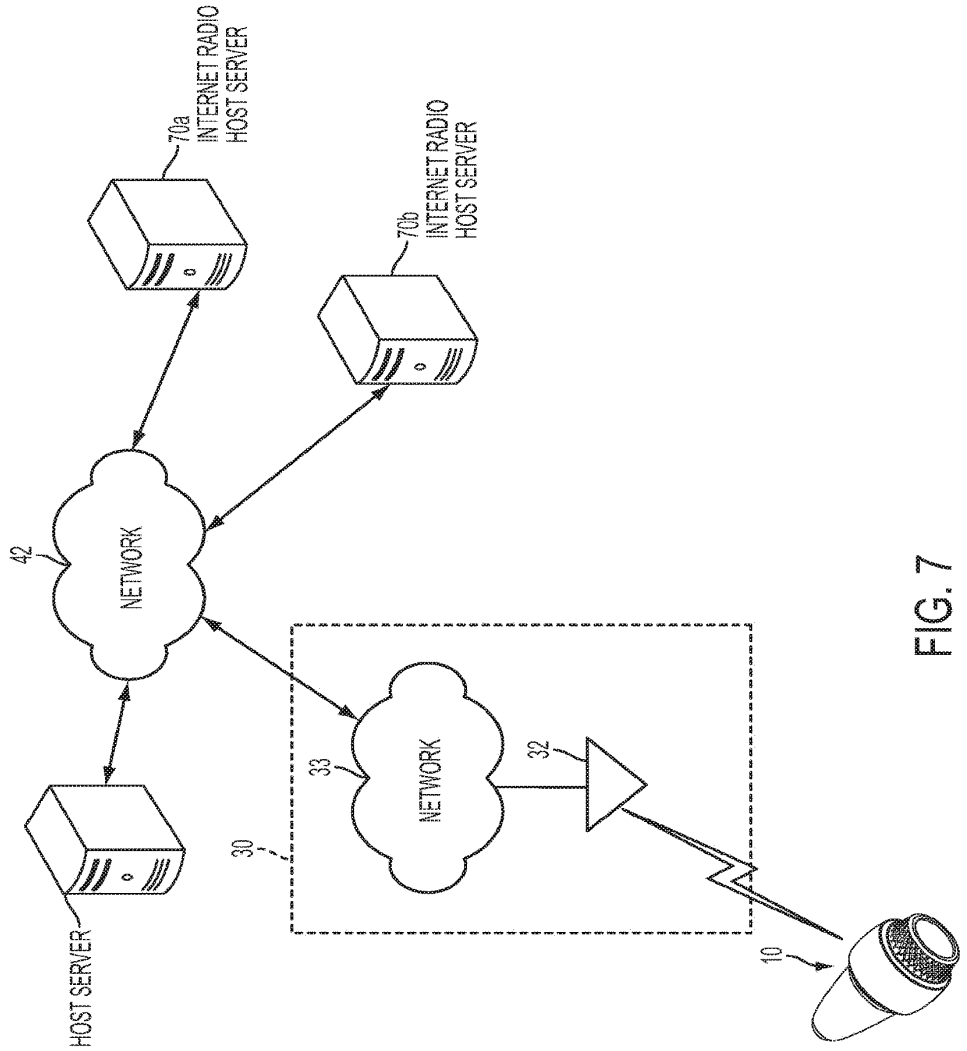
70a
INTERNET RADIO
HOST SERVER
70b
INTERNET RADIO
HOST SERVER
42
NETWORK
33
NETWORK
32
30
HOST SERVER
10

FIG. 7

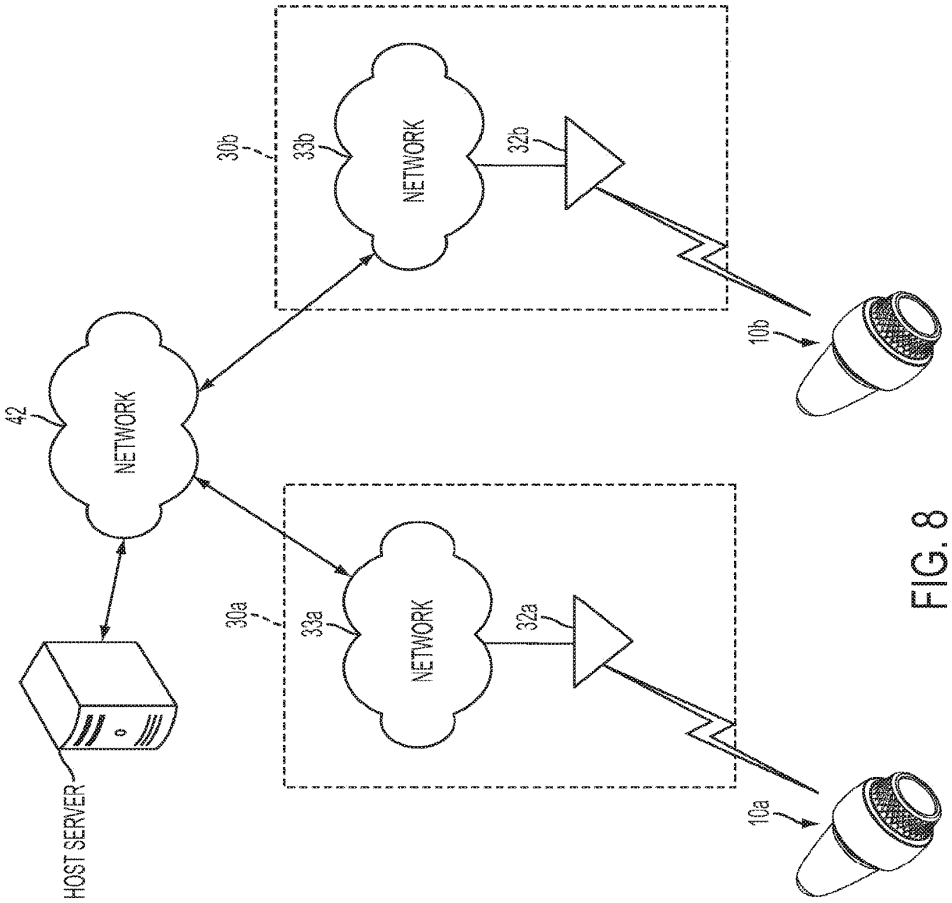
30b
33b
NETWORK
32b
10b
42
NETWORK
30a
33a
NETWORK
32a
10a
HOST SERVER

FIG. 8

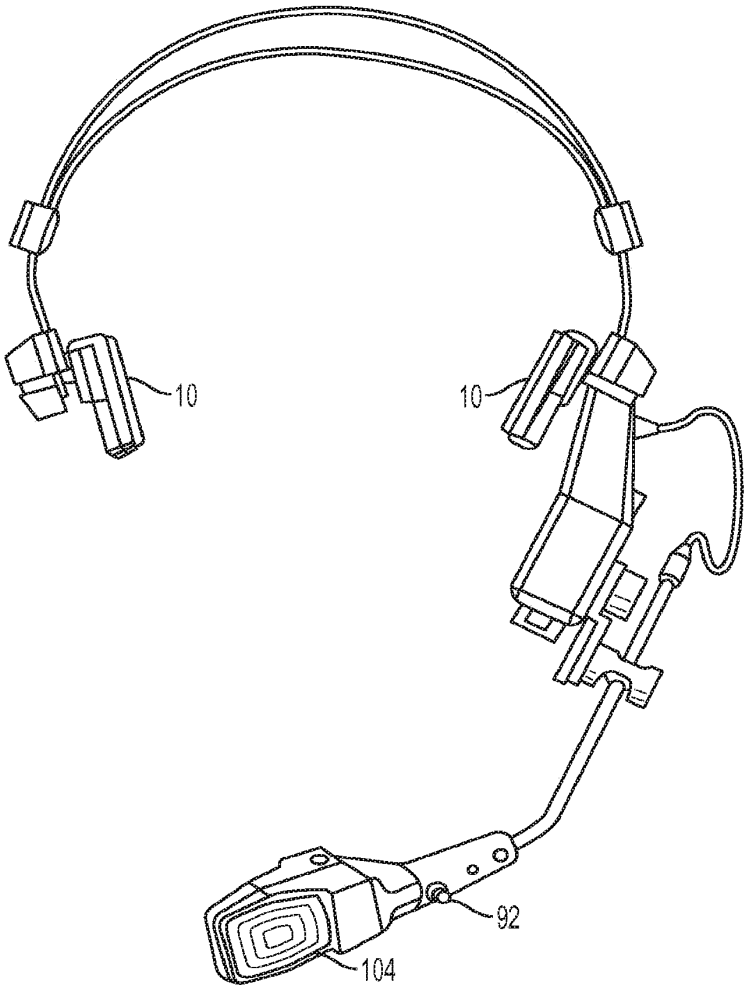

FIG. 9

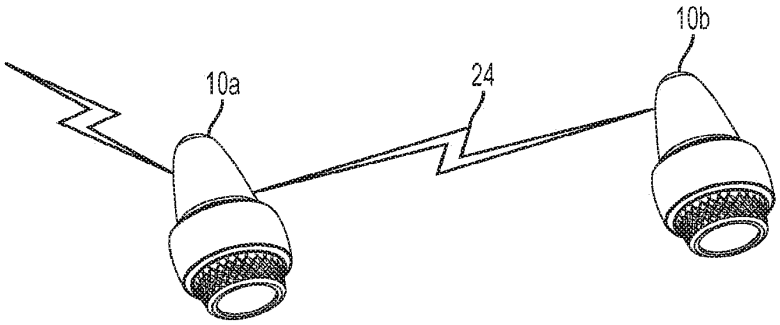

FIG. 10

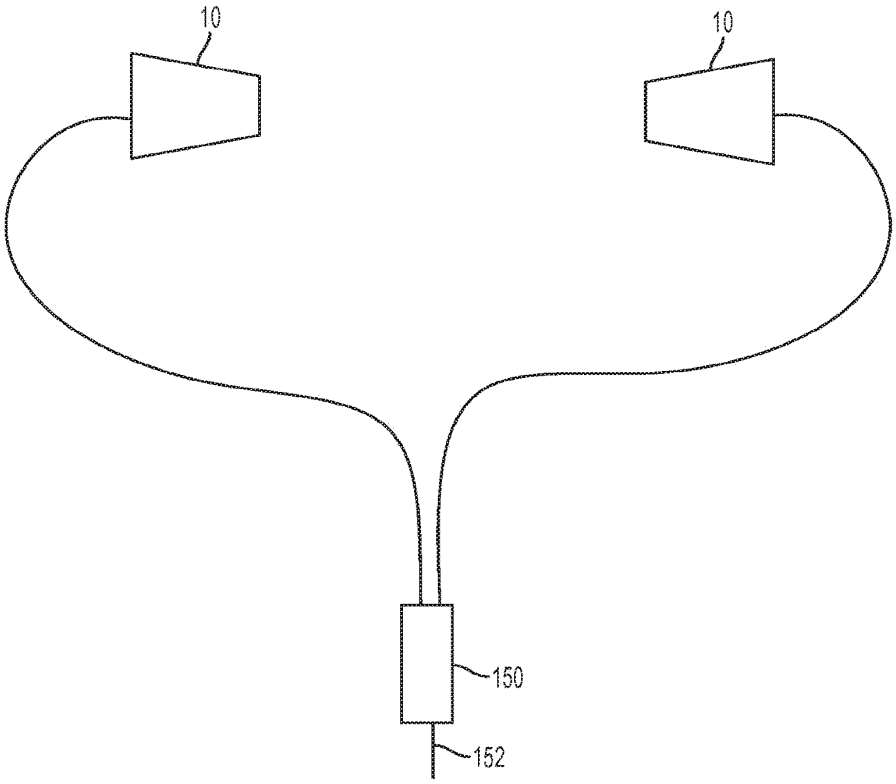

FIG. 11

SYSTEM WITH WIRELESS EARPHONES

PRIORITY CLAIM

The present application claims priority as a continuation to U.S. nonprovisional patent application Ser. No. 16/375,879, filed Apr. 5, 2019, which is a continuation of U.S. nonprovisional patent application Ser. No. 16/182,927, filed Nov. 7, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/962,305, filed Apr. 25, 2018, now U.S. Pat. No. 10,206,025, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/650,362, filed Jul. 14, 2017, now U.S. Pat. No. 9,986,325, issued May 29, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/293,785, filed Oct. 14, 2016, now U.S. Pat. No. 9,729,959, issued Aug. 8, 2017, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/082,040, filed Mar. 28, 2016, now U.S. Pat. No. 9,497,535, issued Nov. 15, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 14/695,696, filed Apr. 24, 2015, now U.S. Pat. No. 9,438,987, issued on Sep. 6, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, issued Jun. 2, 2015, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/459,291, filed Apr. 30, 2012, now U.S. Pat. No. 8,571,544, issued Oct. 29, 2013, which is a continuation of U.S. patent application Ser. No. 12/936,488, filed Dec. 20, 2010, now U.S. Pat. No. 8,190,203, issued May 29, 2012, which is a national stage entry of PCT/US2009/039754, filed Apr. 7, 2009, which claims priority to U.S. provisional patent application Ser. No. 61/123,265, filed Apr. 7, 2008, all of which are incorporated herein by reference in their entireties.

CROSS-REFERENCE TO RELATED APPLICATIONS

U.S. nonprovisional patent application Ser. No. 14/031,938, filed Sep. 13, 2013, now U.S. Pat. No. 8,655,420, issued Feb. 18, 2014, is also a continuation of United States nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, mentioned above.

BACKGROUND

Digital audio players, such as MP3 players and iPods, that store and play digital audio files, are very popular. Such devices typically comprise a data storage unit for storing and playing the digital audio, and a headphone set that connects to the data storage unit, usually with a ¼" or a 3.5 mm jack and associated cord. Often the headphones are in-ear type headphones. The cord, however, between the headphones and the data storage unit can be cumbersome and annoying to users, and the length of the cord limits the physical distance between the data storage unit and the headphones. Accordingly, some cordless headphones have been proposed, such as the Monster iFreePlay cordless headphones from Apple Inc., which include a docking port on one of the earphones that can connect directly to an iPod Shuffle. Because they have the docking port, however, the Monster iFreePlay cordless headphones from Apple are quite large and are not in-ear type phones. Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but such headphones are also quite large and not in-ear type phones.

SUMMARY

In one general aspect, the present invention is directed to a wireless earphone that comprises a transceiver circuit for receiving streaming audio from a data source, such as a digital audio player or a computer, over an ad hoc wireless network. When the data source and the earphone are out of range via the ad hoc wireless network, they may transition automatically to a common infrastructure wireless network (e.g., a wireless LAN). If there is no common infrastructure wireless network for both the data source and the earphone, the earphone may connect via an available infrastructure wireless network to a host server. The host server may, for example, broadcast streaming audio to the earphone and/or transmit to the earphone a network address (e.g., an Internet Protocol (IP) address) for a network-connected content server that streams digital audio. The earphone may then connect to the content server using the IP address. The content server may be an Internet radio server, including, for example, an Internet radio server that broadcasts streaming audio from the data source or some other content.

These and other advantageous, unique aspects of the wireless earphone are described below.

FIGURES

Various embodiments of the present invention are described herein by way of example in conjunction with the following figures, wherein:

FIGS. **1**A-**1**E are views of a wireless earphone according to various embodiments of the present invention;

FIGS. **2**A-**2**D illustrate various communication modes for a wireless earphone according to various embodiments of the present invention;

FIG. **3** is a block diagram of a wireless earphone according to various embodiments of the present invention;

FIGS. **4**A-**4**B show the wireless earphone connected to another device according to various embodiments of the present invention;

FIG. **5** is a diagram of a process implemented by a host server according to various embodiments of the present invention;

FIG. **6** is a diagram of a process implemented by the wireless earphone to transition automatically between wireless networks according to various embodiments of the present invention;

FIGS. **7**, **8** and **10** illustrate communication systems involving the wireless earphone according to various embodiments of the present invention;

FIG. **9** is a diagram of a headset including a wireless earphone and a microphone according to various embodiments of the present invention; and

FIG. **11** is a diagram of a pair of wireless earphones with a dongle according to various embodiments of the present invention.

DESCRIPTION

In one general aspect, the present invention is directed to a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks. The earphone may comprise one or more in-ear, on-ear, or

over-ear speaker elements. Two exemplary in-ear earphone shapes for the wireless earphone **10** are shown in FIGS. **1**A and **1**B, respectively, although in other embodiments the earphone may take different shapes and the exemplary shapes shown in FIGS. **1**A and **1**B are not intended to be limiting. In one embodiment, the earphone transitions automatically and seamlessly, without user intervention, between communication modes. That is, the earphone may transition automatically from an ad hoc wireless network to an infrastructure wireless network, without user intervention. As used herein, an "ad hoc wireless network" is a network where two (or more) wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point. An "infrastructure wireless network," on the other hand, is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet).

FIGS. **1**A and **1**B show example configurations for a wireless earphone **10** according to various embodiments of the present invention. The examples shown in FIGS. **1**A and **1**B are not limiting and other configurations are within the scope of the present invention. As shown in FIGS. **1**A and **1**B, the earphone **10** may comprise a body **12**. The body **12** may comprise an ear canal portion **14** that is inserted in the ear canal of the user of the earphone **10**. In various embodiments, the body **12** also may comprise an exterior portion **15** that is not inserted into user's ear canal. The exterior portion **15** may comprise a knob **16** or some other user control (such as a dial, a pressure-activated switch, lever, etc.) for adjusting the shape of the ear canal portion **14**. That is, in various embodiments, activation (e.g. rotation) of the knob **16** may cause the ear canal portion **14** to change shape so as to, for example, radially expand to fit snugly against all sides of the user's ear canal. Further details regarding such a shape-changing earbud earphone are described in application PCT/US08/88656, filed 31 Dec. 2008, entitled "Adjustable Shape Earphone," which is incorporated herein by reference in its entirety. The earphone **10** also may comprise a transceiver circuit housed within the body **12**. The transceiver circuit, described further below, may transmit and receive the wireless signals, including receive streaming audio for playing by the earphone **10**. The transceiver circuit may be housed in the exterior portion **15** of the earphone **10** and/or in the ear canal portion **14**.

Although the example earphones **10** shown in FIGS. **1**A and **1**B include a knob **16** for adjusting the shape of the ear canal portion **14**, the present invention is not so limited, and in other embodiments, different means besides a knob **16** may be used to adjust the ear canal portion **14**. In addition, in other embodiments, the earphone **10** may not comprise a shape-changing ear canal portion **14**.

In various embodiments, the user may wear two discrete wireless earphones **10**: one in each ear. In such embodiments, each earphone **10** may comprise a transceiver circuit. In such embodiments, the earphones **10** may be connected by a string or some other cord-type connector to keep the earphones **10** from being separated.

In other embodiments, as shown in FIG. **1**C, a headband **19** may connect the two (left and right) earphones **10**. The headband **19** may be an over-the-head band, as shown in the example of FIG. **1**C, or the headband may be a behind-the-head band. In embodiments comprising a headband **19**, each earphone **10** may comprise a transceiver circuit; hence, each earphone **10** may receive and transmit separately the wireless communication signals. In other embodiments comprising a headband **19**, only one earphone **10** may comprise the transceiver circuit, and a wire may run along the headband **19** to the other earphone **10** to connect thereby the transceiver circuit to the acoustic transducer in the earphone that does not comprise the transceiver circuit. The embodiment shown in FIG. **1**C comprises on-ear earphones **10**; in other embodiments, in-ear or over-ear earphones may be used.

In other embodiments, the earphone **10** may comprise a hanger bar **17** that allows the earphone **10** to clip to, or hang on, the user's ear, as shown in the illustrated embodiment of FIGS. **1**D-**1**E. FIG. **1**D is a perspective view of the earphone and FIG. **1**E is a side view according to one embodiment. As shown in the illustrated embodiment, the earphone **10** may comprise dual speaker elements **106**-A, **106**-B. One of the speaker elements (the smaller one) **106**-A is sized to fit into the cavum concha of the listener's ear and the other element (the larger one) **106**-B is not. The listener may use the hanger bar to position the earphone on the listener's ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener's ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user. More details regarding such a dual element, adjustable earphone may be found in U.S. provisional patent application Ser. No. 61/054,238, which is incorporated herein by reference in its entirety.

FIGS. **2**A-**2**D illustrate various communication modes for a wireless data communication system involving the earphone **10** according to embodiments of the present invention. As shown in FIG. **2**A, the system comprises a data source **20** in communication with the earphone **10** via an ad hoc wireless network **24**. The earphone **10**, via its transceiver circuit (described in more detail below), may communicate wirelessly with a data source **20**, which may comprise a wireless network adapter **22** for transmitting the digital audio wirelessly. For example, the data source **20** may be a digital audio player (DAP), such as an mp3 player or an iPod, or any other suitable digital audio playing device, such as a laptop or personal computer, that stores and/or plays digital audio files. In other embodiments, the data source **20** may generate analog audio, and the wireless network adapter **22** may encode the analog audio into digital format for transmission to the earphone **10**.

The wireless network adapter **22** may be an integral part of the data source **20**, or it may be a separate device that is connected to the data source **20** to provide wireless connectivity for the data source **20**. For example, the wireless network adapter **22** may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source **20** (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network (e.g., the ad hoc wireless network **24** or an infrastructure wireless network). The digital audio transmitted from the data source **20** to the earphone **10** via the wireless networks may comprise compressed or uncompressed audio. Any suitable file format may be used for the audio, including mp3, lossy or lossless WMA, Vorbis, Musepack, FLAC, WAV, AIFF, AU, or any other suitable file format.

When in range, the data source **20** may communicate with the earphone **10** via the ad hoc wireless network **24** using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.11a/b/g/n), WiMAX (IEEE 802.16), Bluetooth, Zigbee, UWB, or any other suitable wireless

communication protocol. For purposes of the description to follow, it is assumed that the data source **20** and the earphone **10** communicate using a Wi-Fi protocol, although the invention is not so limited and other wireless communication protocols may be used in other embodiments of the invention. The data source **20** and the earphone **10** are considered in range for the ad hoc wireless network **24** when the signal strengths (e.g., the RSSI) of the signals received by the two devices are above a threshold minimum signal strength level. For example, the data source **20** and the earphone **10** are likely to be in range for an ad hoc wireless network when then are in close proximity, such as when the wearer of the earphone **10** has the data source **20** on his/her person, such as in a pocket, strapped to their waist or arm, or holding the data source in their hand.

When the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, that is, when the received signals degrade below the threshold minimum signal strength level, both the earphone **10** and the data source **20** may transition automatically to communicate over an infrastructure wireless network (such as a wireless LAN (WLAN)) **30** that is in the range of both the earphone **10** and the data source **20**, as shown in FIG. **2**B. The earphone **10** and the data source **20** (e.g., the wireless network adapter **22**) may include firmware, as described further below, that cause the components to make the transition to a common infrastructure wireless network **30** automatically and seamlessly, e.g., without user intervention. The earphone **10** may cache the received audio in a buffer or memory for a time period before playing the audio. The cached audio may be played after the connection over the ad hoc wireless network is lost to give the earphone **10** and the data source **20** time to connect via the infrastructure wireless network.

For example, as shown in FIG. **2**B, the infrastructure network may comprise an access point **32** that is in the range of both the data source **20** and the earphone **10**. The access point **32** may be an electronic hardware device that acts as a wireless access point for, and that is connected to, a wired and/or wireless data communication network **33**, such as a LAN or WAN, for example. The data source **20** and the earphone **10** may both communicate wirelessly with the access point **32** using the appropriate network data protocol (a Wi-Fi protocol, for example). The data source **20** and the earphone **10** may both transition automatically to an agreed-upon WLAN **30** that is in the range of both devices when they cannot communicate satisfactorily via the ad hoc wireless network **24**. A procedure for specifying an agreed-upon infrastructure wireless network **30** is described further below. Alternatively, the infrastructure wireless network **30** may have multiple access points **32***a-b*, as shown in FIG. **2**C. In such an embodiment, the data source **20** may communicate wirelessly with one access point **32***b* and the earphone **10** may communicate wirelessly with another access point **32***a* of the same infrastructure wireless network **30**. Again, the data source **20** and the earphone **10** may transition to an agreed-upon WLAN.

If there is no suitable common infrastructure wireless network over which the earphone **10** and the data source **20** can communicate, as shown in FIG. **2**D, the earphone **10** may transition to communicate with an access point **32***a* for an available (first) wireless network (e.g., WLAN) **30***a* that is in the range of the earphone **10**. In this mode, the earphone **10** may connect via the wireless network **30***a* to a network-enabled host server **40**. The host server **40** may be connected to the wireless network **30***a* via an electronic data communication network **42**, such as the Internet. In one mode, the host server **40** may transmit streaming digital audio via the networks **33***a*, **42** to the earphone **10**. In another mode, the host server **40** may transmit to the earphone **10** a network address, such as an Internet Protocol (IP) address, for a streaming digital audio content server **70** on the network **42**. Using the received IP address, the earphone **10** may connect to the streaming digital audio content server **70** via the networks **30***a*, **42** to receive and process digital audio from the streaming digital audio content server **70**.

The digital audio content server **70** may be, for example, an Internet radio station server. The digital audio content server **70** may stream digital audio over the network **42** (e.g., the Internet), which the earphone **10** may receive and process. In one embodiment, the streaming digital audio content server **70** may stream digital audio received by the streaming digital audio content server **70** from the data source **20**. For example, where the data source **20** is a wireless-capable device, such as a portable DAP, the data source **20** may connect to the streaming digital audio content server **70** via a wireless network **30***b* and the network **42**. Alternatively, where for example the data source **20** is non-wireless-capable device, such as a PC, the data source **20** may have a direct wired connection to the network **42**. After being authenticated by the streaming digital audio content server **70**, the data source **20** may stream digital audio to the streaming digital audio content server **70**, which may broadcast the received digital audio over the network **42** (e.g., the Internet). In such a manner, the user of the earphone **10** may listen to audio from the data source **20** even when (i) the earphone **10** and the data source **20** are not in communication via an ad hoc wireless network **24** and (ii) the earphone **10** and the data source **20** are not in communication via a common local infrastructure wireless network **30**.

FIG. **3** is a block diagram of the earphone **10** according to various embodiments of the present invention. In the illustrated embodiment, the earphone **10** comprises a transceiver circuit **100** and related peripheral components. As shown in FIG. **3**, the peripheral components of the earphone **10** may comprise a power source **102**, a microphone **104**, one or more acoustic transducers **106** (e.g., speakers), and an antenna **108**. The transceiver circuit **100** and some of the peripheral components (such as the power source **102** and the acoustic transducers **106**) may be housed within the body **12** of the earphone **10** (see FIG. **1**). Other peripheral components, such as the microphone **104** and the antenna **108** may be external to the body **12** of the earphone **10**. In addition, some of the peripheral components, such as the microphone **104**, are optional in various embodiments.

In various embodiments, the transceiver circuit **100** may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone **10**, which is advantageous if the earphone **10** is to be relatively small in size, such as an in-ear earphone (see FIGS. **1**A-**1**B for example). In alternative embodiments, however, the components of the transceiver circuit **100** could be realized with two or more discrete ICs or other components, such as separate ICs for the processors, memory, and RF (e.g., Wi-Fi) module, for example.

The power source **102** may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). In other embodiments, the power source **102** may comprise one or more ultracapacitors (sometimes referred to as supercapacitors) that are charged by a primary power source. In embodiments where the power source **102** comprises a rechargeable battery cell or an ultracapacitor, the battery cell or ultracapacitor, as the case may be, may be charged for use,

for example, when the earphone **10** is connected to a docking station or computer. The docking station may be connected to or part of a computer device, such as a laptop computer or PC. In addition to charging the rechargeable power source **102**, the docking station and/or computer may facilitate downloading of data to and/or from the earphone **10**. In other embodiments, the power source **102** may comprise capacitors passively charged with RF radiation, such as described in U.S. Pat. No. 7,027,311. The power source **102** may be coupled to a power source control module **103** of transceiver circuit **100** that controls and monitors the power source **102**.

The acoustic transducer(s) **106** may be the speaker element(s) for conveying the sound to the user of the earphone **10**. According to various embodiments, the earphone **10** may comprise one or more acoustic transducers **106**. For embodiments having more than one transducer, one transducer may be larger than the other transducer, and a crossover circuit (not shown) may transmit the higher frequencies to the smaller transducer and may transmit the lower frequencies to the larger transducer. More details regarding dual element earphones are provided in U.S. Pat. No. 5,333,206, assigned to Koss Corporation, which is incorporated herein by reference in its entirety.

The antenna **108** may receive and transmit the wireless signals from and to the wireless networks **24**, **30**. A RF (e.g., Wi-Fi) module **110** of the transceiver circuit **100** in communication with the antenna **108** may, among other things, modulate and demodulate the signals transmitted from and received by the antenna **108**. The RF module **110** communicates with a baseband processor **112**, which performs other functions necessary for the earphone **10** to communicate using the Wi-Fi (or other communication) protocol.

The baseband processor **112** may be in communication with a processor unit **114**, which may comprise a microprocessor **116** and a digital signal processor (DSP) **118**. The microprocessor **116** may control the various components of the transceiver circuit **100**. The DSP **114** may, for example, perform various sound quality enhancements to the digital audio received by the baseband processor **112**, including noise cancellation and sound equalization. The processor unit **114** may be in communication with a volatile memory unit **120** and a non-volatile memory unit **122**. A memory management unit **124** may control the processor unit's access to the memory units **120**, **122**. The volatile memory **122** may comprise, for example, a random access memory (RAM) circuit. The non-volatile memory unit **122** may comprise a read only memory (ROM) and/or flash memory circuits. The memory units **120**, **122** may store firmware that is executed by the processor unit **114**. Execution of the firmware by the processor unit **114** may provide various functionality for the earphone **10**, such as the automatic transition between wireless networks as described herein. The memory units **120**, **122** may also cache received digital audio.

A digital-to-analog converter (DAC) **125** may convert the digital audio from the processor unit **114** to analog form for coupling to the acoustic transducer(s) **106**. An I^2S interface **126** or other suitable serial or parallel bus interface may provide the interface between the processor unit **114** and the DAC **125**. An analog-to-digital converter (ADC) **128**, which also communicates with the I^2S interface **126**, may convert analog audio signals picked up by the microphone **104** for processing by the processor unit **114**.

The transceiver circuit **100** also may comprise a USB or other suitable interface **130** that allows the earphone **10** to be connected to an external device via a USB cable or other suitable link. As shown in FIG. **4**A, the external device may be a docking station **200** connected to a computer device **202**. Also, in various embodiments, the earphone **10** could be connected directly to the computer **202** without the docking station **200**. In addition, the external device may be a DAP **210**, as shown in FIG. **4**B. In that way, the earphone **10** could connect directly to a data source **20**, such as the DAP **210** or the computer **202**, through the USB port **130**. In addition, through the USB port **130**, the earphone **10** may connect to a PC **202** or docking station **202** to charge up the power source **102** and/or to get downloads (e.g., data or firmware).

According to various embodiments, the earphone **10** may have an associated web page that a user may access through the host server **40** (see FIG. **2**D) or some other server. An authenticated user could log onto the website from a client computing device **50** (e.g., laptop, PC, handheld computer device, etc., including the data source **20**) (see FIG. **2**D) to access the web page for the earphone **10** to set various profile values for the earphone **10**. For example, at the web site, the user could set various content features and filters, as well as adjust various sound control features, such as treble, bass, frequency settings, noise cancellation settings, etc. In addition, the user could set preferred streaming audio stations, such as preferred Internet radio stations or other streaming audio broadcasts. That way, instead of listening to streaming audio from the data source **20**, the user could listen to Internet radio stations or other streaming audio broadcasts received by the earphone **10**. In such an operating mode, the earphone user, via the web site, may prioritize a number of Internet radio stations or other broadcast sources (hosted by streaming digital audio content servers **70**). With reference to FIG. **7**, the host server **40** may send the IP address for the earphone user's desired (e.g., highest priority) Internet radio station to the earphone **10**. A button **11** on the earphone **10**, such as on the rotating dial **16** as shown in the examples of FIGS. **1**A and **1**B, may allow the user to cycle through the preset preferred Internet radio stations. That is, for example, when the user presses the button **11**, an electronic communication may be transmitted to the host server **40** via the wireless network **30**, and in response to receiving the communication, the host server **40** may send the IP address for the user's next highest rated Internet radio station via the network **42** to the earphone **10**. The earphone **10** may then connect to the streaming digital audio content server **70** for that Internet radio station using the IP address provided by the host server **40**. This process may be repeated, e.g., cycled through, for each preset Internet radio station configured by the user of the earphone **10**.

At the web site for the earphone **10** hosted on the host server **40**, in addition to establishing the identification of digital audio sources (e.g., IDs for the user's DAP or PC) and earphones, the user could set parental or other user controls. For example, the user could restrict certain Internet radio broadcasts based on content or parental ratings, etc. That is, for example, the user could configure a setting through the web site that prevents the host server **40** from sending an IP address for a streaming digital audio content server **70** that broadcasts explicit content based on a rating for the content. In addition, if a number of different earphones **10** are registered to the same user, the user could define separate controls for the different earphones **10** (as well as customize any other preferences or settings particular to the earphones **10**, including Internet radio stations, sound quality settings, etc. that would later be downloaded to the earphones **10**). In addition, in modes where the host server **40** streams audio to the earphone **10**, the host server

40 may log the files or content streamed to the various earphones 10, and the user could view at the web site the files or content that were played by the earphones 10. In that way, the user could monitor the files played by the earphones 10.

In addition, the host server 40 may provide a so-called eavesdropping function according to various embodiments. The eavesdropping service could be activated via the web site. When the service is activated, the host server 40 may transmit the content that it is delivering to a first earphone 10*a* to another, second earphone 10*b*, as shown in FIG. 8. Alternatively, the host server 40 may transmit to the second earphone 10*b* the most recent IP address for a streaming digital audio content server 70 that was sent to the first earphone 10*a*. The second earphone 10*b* may then connect to the streaming digital audio content server 70 that the first earphone 10*a* is currently connected. That way, the user of the second earphone 10*b*, which may be a parent, for example, may directly monitor the content being received by the first earphone 10*a*, which may belong to a child of the parent.

This function also could be present in the earphones 10 themselves, allowing a parent (or other user) to join an ad-hoc wireless network and listen to what their child (or other listener) is hearing. For example, with reference to FIG. 10, a first earphone 10*a* may receive wireless audio, such as from the data source 20 or some other source, such as the host server 40. The first earphone 10*a* may be programmed with firmware to broadcast the received audio to a second earphone 10*b* via an ad hoc wireless network 24. That way, the wearer of the second earphone 10*b* can monitor in real-time the content being played by the first earphone 10*a*.

At the web site, the user may also specify the identification number ("ID") of their earphone(s) 10, and the host server 40 may translate the ID to the current internet protocol (IP) addresses for the earphone 10 and for the data source 20. This allows the user to find his or her data source 20 even when it is behind a firewall or on a changing IP address. That way, the host server 40 can match the audio from the data source 20 to the appropriate earphone 10 based on the specified device ID. The user also could specify a number of different data sources 20. For example, the user's DAP may have one specified IP address and the user's home (or work) computer may have another specified IP address. Via the web site hosted by the host server 40, the user could specify or prioritize from which source (e.g., the user's DAP or computer) the earphone 10 is to receive content.

The host server 40 (or some other server) may also push firmware upgrades and/or data updates to the earphone 10 using the IP addresses of the earphone 10 via the networks 30, 42. In addition, a user could download the firmware upgrades and/or data updates from the host server 40 to the client computing device 202 (see FIG. 4A) via the Internet, and then download the firmware upgrades and/or data updates to the earphone 10 when the earphone 10 is connected to the client computer device 202 (such as through a USB port and/or the docking station 200).

Whether the downloads are transmitted wirelessly to the earphone 10 or via the client computing device 202 may depend on the current data rate of the earphone 10 and the quantity of data to be transmitted to the earphone 10. For example, according to various embodiments, as shown in the process flow of FIG. 5, the host server 40 may be programmed, at step 50, to make a determination, based on the current data rate for the earphone 10 and the size of the update, whether the update should be pushed to the earphone 10 wirelessly (e.g., via the WLAN 30*a* in FIG. 2D). If the update is too large and/or the current data rate is too low that the performance of the earphone 10 will be adversely affected, the host server 40 may refrain from pushing the update to the earphone 10 wirelessly and wait instead to download the update to the client computing device 202 at step 51. Conversely, if the host server 40 determines that, given the size of the update and the current data rate for the earphone 10 that the performance of the earphone 10 will not be adversely affected, the host server 40 may transmit the update wirelessly to the earphone 10 at step 52.

As mentioned above, the processor unit 114 of the speakerphones 14 may be programmed, via firmware stored in the memory 120, 122, to have the ability to transition automatically from the ad hoc wireless network 24 to an infrastructure wireless network 30 (such as a WLAN) when the quality of the signal on the ad hoc wireless network 24 degrades below a suitable threshold (such as when the data source 20 is out of range for an ad hoc wireless network). In that case, the earphone 10 and the data source 20 may connect to a common infrastructure wireless network (e.g., WLAN) (see, for example, FIGS. 2B-2C). Through the web site for the earphone 10, described above, the user could specify a priority of infrastructure wireless networks 30 for the data source 20 and the earphone 10 to connect to when the ad hoc wireless network 24 is not available. For example, the user could specify a WLAN servicing his/her residence first, a WLAN servicing his/her place of employment second, etc. During the time that the earphone 10 and the data source 20 are connected via the ad hoc wireless network 24, the earphone 10 and the data source 20 may exchange data regarding which infrastructure networks are in range. When the earphone 10 and the data source 20 are no longer in range for the ad hoc wireless network 24 (that is, for example, the signals between the device degrade below an acceptable level), they may both transition automatically to the highest prioritized infrastructure wireless network whose signal strength is above a certain threshold level. That way, even though the earphone 10 and the data source 20 are out of range for the ad hoc wireless network 24, the earphone 10 may still receive the streaming audio from the data source 20 via the infrastructure wireless network 30 (see FIGS. 2B-2C).

When none of the preferred infrastructure networks is in range, the earphone 10 may connect automatically to the host server 40 via an available infrastructure wireless network 30 (see FIG. 2D), e.g., the infrastructure wireless network 30 having the highest RSSI and to which the earphone 10 is authenticated to use. The host server 40, as mentioned above, may transmit IP addresses to the earphone 10 for streaming digital audio content servers 70 or the host sever 40 may stream digital audio to the earphone 10 itself when in this communication mode.

FIG. 6 is a diagram of the process flow, according to one embodiment, implemented by the transceiver circuit 100 of the earphone 10. The process shown in FIG. 6 may be implemented in part by the processor unit 114 executing firmware stored in a memory unit 120, 122 of the transceiver circuit 100. At step 61, the earphone 10 may determine if it can communicate with the data source 20 via an ad hoc wireless network 24. That is, the earphone 10 may determine if the strength of the wireless signals from the data source 20 exceed some minimum threshold. If so, the data source 20 and the earphone 10 may communicate wirelessly via the ad hoc wireless network 24 (see FIG. 2A). While in this communication mode, at step 62, the data source 20 and the earphone 10 also may exchange data regarding the local

infrastructure wireless networks, if any, in the range of the data source **20** and the earphone **10**, respectively. For example, the earphone **10** may transmit the ID of local infrastructure wireless networks **30** that the earphone **10** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. Similarly, the data source **20** may transmit the ID the local infrastructure wireless networks **30** that the data source **20** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. The earphone **10** may save this data in a memory unit **120**, **122**. Similarly, the data source **20** may store in memory the wireless networks that the earphone **10** is detected.

The data source **20** and the earphone **10** may continue to communicate via the ad hoc wireless network mode **24** until they are out of range (e.g., the signal strengths degrade below a minimum threshold level). If an ad hoc wireless network **24** is not available at block **61**, the transceiver circuit **100** and the data source **20** may execute a process, shown at block **63**, to connect to the user's highest prioritized infrastructure wireless network **30**. For example, of the infrastructure wireless networks whose signal strength exceeded the minimum threshold for both the earphone **10** and the data source **20** determined at step **62**, the earphone **10** and the data source **20** may both transition to the infrastructure wireless network **30** having the highest priority, as previously set by the user (seen FIGS. **2**B-**2**C, for example). For example, if the user's highest prioritized infrastructure wireless network **30** is not available, but the user's second highest prioritized infrastructure wireless network **30** is, the earphone **10** and the data source **20** may both transition automatically to the user's second highest prioritized infrastructure wireless network **30** at block **64**. As shown by the loop with block **65**, the earphone **10** and the data source **20** may continue to communicate via one of the user's prioritized infrastructure wireless networks **30** as long as the infrastructure wireless network **30** is available. If the infrastructure wireless network becomes unavailable, the process may return to block **61**.

If, however, no ad hoc wireless network and none of the user's prioritized infrastructure wireless networks are available, the earphone **10** may transition automatically to connect to the host server **40** at block **66** (see FIG. **2**D) using an available infrastructure wireless network **30**. At block **67**, the host server **40** may transmit an IP address to the earphone **10** for one of the streaming digital audio content servers **70**, and at block **68** the earphone **10** may connect to the streaming digital audio content server **70** using the received IP address. At step **69**, as long as the earphone **10** is connected to the streaming digital audio content server **70**, the earphone **10** may continue to communicate in this mode. However, if the earphone **10** loses its connection to the digital audio content server **70**, the process may return to block **61** in one embodiment. As mentioned above, at block **67**, instead of sending an IP address for a streaming digital audio content server **70**, the host server **40** may stream digital audio to the earphone **10**. The user, when configuring their earphone **10** preferences via the web site, may specify and/or prioritize whether the host server **40** is to send IP addresses for the streaming digital audio content servers **70** and/or whether the host server **40** is to stream audio to the earphone **10** itself.

In another embodiment, the earphone **10** may be programmed to transition automatically to the host server **40** when the earphone **10** and the data source **20** are not in communication via the ad hoc wireless network **24**. That is, in such an embodiment, the earphone **10** may not try to connect via a local infrastructure wireless network **30** with the data source **20**, but instead transition automatically to connect to the host server **40** (see FIG. **2**D).

In various embodiments, as shown in FIG. **1**B, the button **11** or other user selection device that allows the wearer of the earphone **10** to indicate approval and/or disapproval of songs or other audio files listened to by the wearer over an Internet radio station. The approval/disapproval rating, along with metadata for the song received by the earphone **10** with the streaming audio, may be transmitted from the transceiver circuit **100** of the earphone **10** back to the host server **40**, which may log the songs played as well as the ratings for the various songs/audio files. In addition to being able to view the logs at the website, the host server **40** (or some other server) may send an email or other electronic communication to the earphone user, at a user specified email address or other address, which the user might access from their client communication device **50** (see FIG. **2**D). The email or other electronic communication may contain a listing of the song/audio files for which the user gave approval ratings using the button **11** or other user selection device. Further, the email or other electronic communication may provide a URL link for a URL at which the user could download song/audio files that the user rated (presumably song/audio files for which the user gave an approval rating). In some instances, the user may be required to pay a fee to download the song/audio file.

The user song ratings also may be used by the host server **40** to determine the user's musical preferences and offer new music that the user might enjoy. More details about generating user play lists based on song ratings may be found in published U.S. patent applications Pub. No. 2006/0212444, Pub. No. 2006/0206487, and Pub. No. 2006/0212442, and U.S. Pat. No. 7,003,515, which are incorporated herein by reference in their entirety.

In addition or alternatively, the user could log onto a web site hosted by the host server **40** (or some other server) to view the approval/disapproval ratings that the user made via the button **11** on the earphone **10**. The web site may provide the user with the option of downloading the rated songs/audio files (for the host server **40** or some other server system) to their client computer device **50**. The user could then have their earphone **10** connect to their client computer device **50** as a data source **20** via an ad hoc wireless network **24** (see FIG. **2**A) or via an infrastructure wireless network (see FIGS. **2**B-**2**D) to listen to the downloaded songs. In addition, the user could download the song files from their client computer device **50** to their DAP and listen to the downloaded song files from their DAP by using their DAP as the data source **20** in a similar manner.

Another application of the headsets may be in vehicles equipped with Wi-Fi or other wireless network connectivity. Published PCT application WO 2007/136620, which is incorporated herein by reference, discloses a wireless router for providing a Wi-Fi or other local wireless network for a vehicle, such as a car, truck, boat, bus, etc. In a vehicle having a Wi-Fi or other local wireless network, the audio for other media systems in the vehicle could be broadcast over the vehicle's wireless network. For example, if the vehicle comprises a DVD player, the audio from the DVD system could be transmitted to the router and broadcast over the vehicle's network. Similarly, the audio from terrestrial radio stations, a CD player, or an audio cassette player could be broadcast over the vehicle's local wireless network. The vehicle's passengers, equipped with the earphones **10**, could cycle through the various audio broadcasts (including the broadcasts from the vehicle's media system as well as broadcasts from the host server **40**, for example) using a

selection button **11** on the earphone **10**. The vehicle may also be equipped with a console or terminal, etc., through which a passenger could mute all of the broadcasts for direct voice communications, for example.

As described above, the earphones **10** may also include a microphone **104**, as shown in the example of FIG. **9**. The headset **90** shown in FIG. **9** includes two earphones **10**, both of which may include a transceiver circuit **100** or only one of which may include the transceiver circuit, as discussed above. The microphone **104** could be used to broadcast communications from one earphone wearer to another earphone wearer. For example, one wearer could activate the microphone by pressing a button **92** on the headset **90**. The headset **90** may then transmit a communication via an ad hoc wireless network **24** or other wireless network to a nearby recipient (or recipients) equipped with a headset **90** with a transceiver circuit **100** in one or both of the earphones **10**. When such communication is detected by the recipient's headset **90**, the streaming audio received over the wireless network by the recipient's headset **90** may be muted, and the intercom channel may be routed to the transducer(s) of the recipient's headset **90** for playing for the recipient. This functionality may be valuable and useful where multiple wearers of the headsets **90** are in close proximity, such as on motorcycles, for example.

Another exemplary use of the earphones **10** is in a factory, warehouse, construction site, or other environment that might be noisy. Persons (e.g., workers) in the environment could use the earphones **10** for protection from the surrounding noise of the environment. From a console or terminal, a person (e.g., a supervisor) could select a particular recipient for a communication over the Wi-Fi network (or other local wireless network). The console or terminal may have buttons, dials, or switches, etc., for each user/recipient, or it could have one button or dial through which the sender could cycle through the possible recipients. In addition, the console or terminal could have a graphical user interface, through which the sender may select the desired recipient(s).

As mentioned above, the earphones **10** may comprise a USB port. In one embodiment, as shown in FIG. **11**, the user may use an adapter **150** that connects to the USB port of each earphone **10**. The adapter **150** may also have a plug connector **152**, such as a 3.5 mm jack, which allows the user to connect the adapter **150** to devices having a corresponding port for the connector **152**. When the earphones **10** detect a connection via their USB interfaces in such a manner, the Wi-Fi (or other wireless protocol) components may shut down or go into sleep mode, and the earphones **10** will route standard headphone level analog signals to the transducer(s) **106**. This may be convenient in environments where wireless communications are not permitted, such as airplanes, but where there is a convenient source of audio contact. For example, the adapter **150** could plug into a person's DAP. The DSP **118** of the earphone **10** may still be operational in such a non-wireless mode to provide noise cancellation and any applicable equalization.

The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect of the examples is/are intended to limit the scope of the described embodiments.

According to various embodiments, therefore, the present invention is directed to an earphone **10** that comprises a body **12**, where the body **12** comprises: (i) at least one acoustic transducer **106** for converting an electrical signal to sound; (ii) an antenna **108**; and (iii) a transceiver circuit **100** in communication with the at least one acoustic transducer **106** and the antenna **108**. The transceiver circuit **100** is for receiving and transmitting wireless signals via the antenna **108**, and the transceiver circuit **100** is for outputting the electrical signal to the at least one acoustic transducer **106**. The wireless transceiver circuit also comprises firmware, which when executed by the transceiver circuit, causes the transceiver circuit to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the earphone **10** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

According to various implementations, the data source may comprise a portable digital audio player, such as an MP3 player, iPod, or laptop computer, or a nonportable digital audio player, such as a personal computer. In addition, the transceiver circuit **100** may comprise: (i) a wireless communication module **110** (such as a Wi-Fi or other wireless communication protocol module); (ii) a processor unit **114** in communication with the wireless communication module **110**; (iii) a non-volatile memory unit **122** in communication with the processor unit **114**; and (iv) a volatile memory **120** unit in communication with the processor unit **114**. The infrastructure wireless network may comprise a WLAN. The transceiver circuit **100** may receive digital audio from the data source **20** via the infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transition automatically to a pre-set infrastructure wireless network **30** that the data source **20** transitions to when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24** and when the pre-set infrastructure wireless network **30** is in range of both the earphone **10** and the data source **20**. In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transmit data via the ad hoc wireless network **24** to the data source **20** regarding one or more infrastructure wireless networks **30** detected by the transceiver circuit **100** when the earphone **10** and the data source **20** are communicating via the ad hoc wireless network **24**.

In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to connect to a host server **40** via an available infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The earphone **10** may receive streaming digital audio from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may receive a first network address for a first streaming digital audio content server **70** from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may comprise a user control, such as button **11**, dial, pressure switch, or other type of user control, that, when activated, causes the earphone **10** to transmit an electronic request via the infrastructure wireless network **30** to the host server **40** for a second network address for a second streaming digital audio content server **70**.

In other embodiments, the present invention is directed to a system that comprises: (i) a data source **20** for wirelessly

transmitting streaming digital audio; and (ii) a wireless earphone **10** that is in wireless communication with the data source **20**. In yet other embodiments, the present invention is directed to a communication system that comprises: (i) a host server **40**; (ii) a first streaming digital audio content server **70** that is connected to the host server **40** via a data network **42**; and (iii) a wireless earphone **10** that is in communication with the host server **40** via a wireless network **30**. The host server **40** is programmed to transmit to the earphone **10** a first network address for the first streaming digital audio content server **70** on the data network **42**. The host server **40** and the streaming digital audio content server(s) **70** each may comprise one or more processor circuits and one or more memory circuits (e.g., ROM circuits and/or RAM circuits).

In yet another embodiment, the present invention is directed to a headset that comprises: (i) a first earphone **10***a* that comprises one or more acoustic transducers **10***b* for converting a first electrical signal to sound; and (ii) a second earphone **10***b*, connected to the first earphone **10***a*, wherein the second earphone **10***b* comprises one or more acoustic transducers **10***b* for converting a second electrical signal to sound. In one embodiment, the first earphone **10***a* comprises: (i) a first antenna **108**; and (ii) a first transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the first earphone **10***a* and in communication with the first antenna **108**. The first transceiver circuit **100** is for receiving and transmitting wireless signals via the first antenna **108**, and for outputting the first electrical signal to the one or more acoustic transducers **10***b* of the first earphone **10***a*. The first transceiver circuit **100** also may comprise firmware, which when executed by the first transceiver circuit **100**, causes the first transceiver circuit **100** to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the first earphone **10***a* via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the first earphone **10***a* via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

In various implementations, the headset further may comprise a head band **19** that is connected to the first and second earphones **10**. In addition, the headset **19** further may comprise a microphone **104** having an output connected to the first transceiver circuit **100**. In one embodiment, the first transceiver circuit **100** is for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10***b*. In another embodiment, the second earphone **10***b* comprises: (i) a second antenna **108**; and (ii) a second transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the second earphone **10***b* and in communication with the second antenna **108**. The second transceiver circuit **100** is for receiving and transmitting wireless signals via the second antenna **108**, and for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10***b*. The second transceiver circuit **100** may comprise firmware, which when executed by the second transceiver circuit **100**, causes the second transceiver circuit **100** to: (i) receive digital audio wirelessly from the data source **20** via the ad hoc wireless network **24** when the data source **20** is in wireless communication range with the second earphone **10***b* via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the second earphone **10***b* via the ad hoc wireless network **24**, transition automatically to receive digital audio via the infrastructure wireless network **30**.

In addition, according to various embodiments, the first earphone **10***a* may comprise a first data port and the second earphone **10***b* may comprise a second data port. In addition, the headset may further comprise an adapter or dongle **150** connected to the first data port of the first earphone **10***a* and to the second data port of the second earphone **10***b*, wherein the adapter **150** comprises an output plug connector **152** for connecting to a remote device.

In addition, according to other embodiments, the present invention is directed to a method that comprises the steps of: (i) receiving, by a wireless earphone, via an ad hoc wireless network, digital audio from a data source when the data source is in wireless communication with the earphone via the ad hoc wireless network; (ii) converting, by the wireless earphone, the digital audio to sound; and (iii) when the data source is not in wireless communication with the earphone, transitioning automatically, by the earphone, to receive digital audio via an infrastructure wireless network.

In various implementations, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprises transitioning automatically to receive digital audio from the data source via an infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. In addition, the method may further comprise the step of receiving by the wireless earphone from the data source via the ad hoc wireless network data regarding one or more infrastructure wireless networks detected by data source when the earphone and the data source are communicating via the ad hoc wireless network.

In addition, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network comprises may transitioning automatically to receive digital audio from a host sever via the infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. Additionally, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise: (i) receiving, by the wireless earphone via the infrastructure wireless network, from a host server connected to the infrastructure wireless network, a network address for a streaming digital audio content server; and (ii) connecting, by the wireless earphone, to the streaming digital audio content server using the network address received from the host server.

It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments, while eliminating, for purposes of clarity, other elements. For example, certain operating system details for the various computer-related devices and systems are not described herein. Those of ordinary skill in the art will recognize, however, that these and other elements may be desirable in a typical processor or computer system. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

In general, it will be apparent to one of ordinary skill in the art that at least some of the embodiments described herein may be implemented in many different embodiments of software, firmware and/or hardware. The software and firmware code may be executed by a processor or any other similar computing device. The software code or specialized control hardware that may be used to implement embodi-

ments is not limiting. For example, embodiments described herein may be implemented in computer software using any suitable computer software language type. Such software may be stored on any type of suitable computer-readable medium or media, such as, for example, a magnetic or optical storage medium. The operation and behavior of the embodiments may be described without specific reference to specific software code or specialized hardware components. The absence of such specific references is feasible, because it is clearly understood that artisans of ordinary skill would be able to design software and control hardware to implement the embodiments based on the present description with no more than reasonable effort and without undue experimentation.

Moreover, the processes associated with the present embodiments may be executed by programmable equipment, such as computers or computer systems and/or processors. Software that may cause programmable equipment to execute processes may be stored in any storage device, such as, for example, a computer system (nonvolatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, at least some of the processes may be programmed when the computer system is manufactured or stored on various types of computer-readable media.

A "computer," "computer system," "host," "host server," "server," or "processor" may be, for example and without limitation, a processor, microcomputer, minicomputer, server, mainframe, laptop, personal data assistant (PDA), wireless e-mail device, cellular phone, pager, processor, fax machine, scanner, or any other programmable device configured to transmit and/or receive data over a network. Such components may comprise: one or more processor circuits; and one more memory circuits, including ROM circuits and RAM circuits. Computer systems and computer-based devices disclosed herein may include memory for storing certain software applications used in obtaining, processing, and communicating information. It can be appreciated that such memory may be internal or external with respect to operation of the disclosed embodiments. The memory may also include any means for storing software, including a hard disk, an optical disk, floppy disk, ROM (read only memory), RAM (random access memory), PROM (programmable ROM), EEPROM (electrically erasable PROM) and/or other computer-readable media.

In various embodiments disclosed herein, a single component may be replaced by multiple components and multiple components may be replaced by a single component to perform a given function or functions. Except where such substitution would not be operative, such substitution is within the intended scope of the embodiments. Any servers described herein, such as the host server **40**, for example, may be replaced by a "server farm" or other grouping of networked servers (such as server blades) that are located and configured for cooperative functions. It can be appreciated that a server farm may serve to distribute workload between/among individual components of the farm and may expedite computing processes by harnessing the collective and cooperative power of multiple servers. Such server farms may employ load-balancing software that accomplishes tasks such as, for example, tracking demand for processing power from different machines, prioritizing and scheduling tasks based on network demand and/or providing backup contingency in the event of component failure or reduction in operability.

While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

What is claimed is:

1. A system comprising:

headphones comprising a pair of first and second wireless earphones to be worn simultaneously by a user, wherein the first and second earphones are separate such that when the headphones are worn by the user, the first and second earphones are not physically connected, wherein each of the first and second earphones comprises:

a body portion that comprises:

a wireless communication circuit for receiving and transmitting wireless signals;

a processor circuit in communication with the wireless communication circuit; and

an ear canal portion that is inserted into an ear of the user when worn by the user; and

at least one acoustic transducer connected to the processor circuit; and

an elongated portion that extends away from the body portion such that the elongated portion extends downwardly when the ear canal portion is inserted in the ear of the user;

a microphone connected to the processor circuit and for picking up utterances of a user of the headphones;

an antenna connected to the wireless communication circuit; and

a rechargeable power source; and

a mobile, digital audio player that stores digital audio content and that comprises a wireless transceiver for transmitting digital audio content to the headphones via Bluetooth wireless communication links, such that each earphone receives and plays audio content received wirelessly via the Bluetooth wireless communication links from the mobile, digital audio player.

2. The system of claim **1**, further comprising a docking station for holding at least the first wireless earphone, wherein the docking station comprises a power cable for connecting to an external device for charging the at least the first wireless earphone when the docking station is connected to the external device via the power cable.

3. The system of claim **1**, wherein:

in a first operational mode, the pair of first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the first and second earphones from the mobile, digital audio player via the Bluetooth wireless communication links; and

in a second operational mode, the pair of first and second earphones play audio content streamed from a remote network server.

4. The system of claim **1**, wherein the processor circuit of the first earphone is for, upon activation of a user control of the headphones, initiating transmission of a request to a remote network server that is remote from the mobile, digital audio player and in communication with the mobile, digital audio player via a data communication network.

5. The system of claim **4**, wherein the processor circuit of the first earphone is further for receiving a response to the request.

6. The headphones of claim **5**, wherein:

the mobile digital audio player is a first digital audio source;

the system further comprises a second digital audio player that is different from the first digital audio player; and

the headphones transition to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least in part, a signal strength for the second wireless communication link.

7. The headphones of claim **6**, wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server.

8. The headphones of claim **6**, wherein each of the first and second earphones comprises a buffer for caching the audio content received by the earphone prior to being played by the at least one acoustic transducer of the earphone.

9. The system of claim **8**, wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server.

10. The headphones of claim **9**, wherein the processor circuit of each of the first and second earphones comprises:

a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone; and

a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

11. The system of claim **1**, wherein:

the mobile digital audio player is a first digital audio source;

the system further comprises a second digital audio player that is different from the first digital audio player; and

the headphones transition to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least in part, a signal strength for the second wireless communication link.

12. The headphones of claim **11**, wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server.

13. The headphones of claim **12**, wherein each of the first and second earphones comprises a buffer for caching the audio content received by the earphone prior to being played by the at least one acoustic transducer of the earphone.

14. The system of claim **1**, wherein the processor circuits of the headphones are configured to receive firmware upgrades pushed from a remote network server.

15. The system of claim **1**, wherein the processor circuit of the first earphone is configured to:

process audible utterances by the user picked by the microphone in response to activation of the microphone by the user; and

transmit a communication based on the audible utterances via the Bluetooth wireless communication links.

16. The system of claim **1**, wherein the rechargeable power source comprises a wirelessly chargeable circuit component.

17. The system of claim **1**, wherein the rechargeable power source comprises a passive, wireless rechargeable power source.

18. The system of claim **1**, wherein each of the first and second earphones comprises a buffer for caching the audio content received by the earphone prior to being played by the at least one acoustic transducer of the earphone.

19. The headphones of claim **1**, wherein the processor circuit of each of the first and second earphones comprises a digital signal processor that provides a sound quality enhancement for the audio content played by the at least one acoustic transducers of the earphone.

20. The headphones of claim **19**, wherein the processor circuit of each of the first and second earphones further comprises a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

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UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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Case Number: 2022–2091, 2022–2115

Short Case Caption: Koss Corp. v. Vidal

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